LDX-3620

INSTRUCTION MANUAL

Ultra-Low Noise Current Source

ILX Lightwave

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MODEL LDX-3620

ULTRA LOW NOISE CURRENT SOURCE

INSTRUCTION MANUAL

REV C
May 25, 1990

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4) Description/sketch of what is connected to the ILX Lightwave instrument

We look forward to serving you better in the future!

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Chapter 1

GENERAL INFORMATION

1.1 Introduction

This manual contains operation and maintenance information for the LDX-3620 Ultra Low Noise Current Source and its options. Chapter 2 contains control and connector descriptions and operation procedures. Chapter 3 has the theory for operation of the LDX-3620. Chapter 4 contains battery and maintenance information.

IMPORTANT

To those in a hurry to turn on and use the LDX-3620 without reading Chapter 2 of this manual, it is recommended that the IMPORTANT paragraphs be read since they contain information that may prevent the destruction of expensive laser diodes (see IMPORTANT in the index). The most important operating instructions are located in Section 2.5. Output connector pin-outs are found in Figure 2.3. Recommended cable shielding schemes are found in Figures 2.4 A through D and discussed in Sections 2.5.5 and 2.5.6. Figure 3.1 is a block diagram of the LDX-3620. Battery maintenance information is found in Section 4.2.

1.2 The LDX-3620 Ultra Low Noise Current Source

The LDX-3620 Ultra Low Noise Current Source provides laser diode users a power source for applications requiring current stabilities of better than 10 ppm and noise levels lower than 2 uA in the 5 Hz to 10 MHz band. Its features include:

* Low noise, battery based design
* Built-in battery charger
* High output stability
* Current limit protection
* Two output current ranges: 200 mA and 500 mA
* 4-1/2 digit resolution and display
* Monitor photodiode current display
* Photodiode feedback input for constant optical power operation
* Internal ramp generator with trigger output
* External modulation capability
* Low battery shutdown protection
* High/Low bandwidth switch

1.3 Specifications for the LDX-3620

OUTPUT	0-200 mA RANGE	0-500 mA RANGE
Output Current:	0-200 mA	0-500 mA
Compliance Voltage:	≥5 volts	≥4 volts
Noise and Ripple:		
(5 Hz - 10 MHz bandwidth)		
Battery operation	≤850 nA rms	≤5 uA rms
AC line operation	≤3 uA rms	≤8 uA rms
(5 Hz - 10 KHz bandwidth)		
Battery operation	≤100 nA rms	≤500 nA rms
AC line operation	≤2 uA rms	≤6.5 uA rms
Noise Density:		
(Battery Operation)		
50/60 Hz	5.2 nA/Hz	11.5 nA/Hz
1 KHz	815 pA/Hz	2.6 nA/Hz
25 KHz	315 pA/Hz	795 pA/Hz

Stability:	
10-20 seconds	≤0.1 ppm
3-5 minutes	≤1 ppm
10-30 minutes	≤10 ppm
Temperature Coefficient:	≤10 ppm/°C
Transients:	≤10 uA
Ramp Trigger:	Ramp start trigger for oscilloscope output; Optically isolated open collector TTL output
Ramp Flyback Time:	700 uSec, approximately
Output Connector:	Shielded 9-pin D-sub on rear panel

CURRENT LIMIT

Range:	10-500 mA
Accuracy:	±5 mA

DISPLAY

Type:	4-1/2 digit LCD

	0-200 mA RANGE	0-500 mA RANGE
Resolution:	0.01 mA	0.1 mA
Accuracy:	±0.05 mA	±0.2 mA

Reads: LASER diode current in mA
MONITOR photodiode current in mA

MODULATION / FEEDBACK INPUTS

Photodiode Feedback

Input Type:	Current input from external photodiode
Range:	20 uA to 2 mA for full scale output
Connectors:	Rear Panel Isolated BNC Jack or 9-pin Rear Panel D-sub Connector

Internal Ramp Generator

Period:	Adjustable 50 msec to 100 sec	
Span Adjustment:	0-200 mA	0-500 mA

External Modulation Input

Bandwidth (3 dB point)

AC Coupled:	100 Hz to 1 MHz
DC Coupled:	0 Hz to 1 MHz

	0-200 mA RANGE	0-500 mA RANGE
Transfer Function:	100 mA/V	250 mA/V

Connector: Isolated Front Panel BNC Jack

GENERAL

AC Power

Input Voltage Range	100-125 or 210-250 VAC
Line Frequency	50/60 Hz

Battery

+12 volt supply:	4.5 amp-hour sealed lead-acid battery (standard)
-12 volt supply:	1.2 amp-hour sealed lead-acid battery

Temperature Range

Operating:	0 to 50^{o}C
Storage:	-40 to 70^{o}C

1.4 Options and Accessories

362038 Long Life Battery Option

The 362038 option is a second, user installable +12 volt battery which doubles the battery operation time at 500 mA. Instructions for battery installation are included with the 362038 option kit.

132 Rack Mount Kit

The 132 rack mount kit enables installation of the 3620 into a standard 19 inch wide rack. All hardware and instructions are included with the kit.

Chapter 2

OPERATION

2.1 Introduction

This chapter contains the following aspects of operation of the LDX-3620:

* General power and installation considerations
* A description of the front and rear panel controls and connectors
* Step-by-step instructions on the set-up and use of the LDX-3620

2.2 Installation

Sections 2.2.1 through 2.2.3 discuss topics related to the installation of the LDX-3620.

2.2.1 AC Power/ Battery Charge Considerations

The LDX-3620 is normally configured at the factory for your power line voltage. The unit can be configured for 100-130 VAC or 210-230 VAC operation. Check to be sure that the correct range is marked on the rear panel. If it is not correct, see Section 4.4 for the procedure to change the line voltage range.

The AC power cord connects to the rear of the unit. Turning on the AC POWER switch on the rear panel charges the batteries while permitting full use of the LDX-3620's functions; however, noise will be increased in this configuration.

2.2.2 Tilt-foot Adjustment

The LDX-3620 can be tilted for easier viewing using the extensions on the front feet of the unit. These extenders can be rotated 90 degrees until they lock into position. To put the extenders flat against the bottom of the unit, firmly press them back.

2.2.3 Rack Mounting

The instructions and necessary hardware for mounting the LDX-3620 in a standard 19 inch wide instrument rack are available in the model 332 Rack Mounting Kit. Contact the factory for more information.

2.3 Front Panel Controls and Connectors

A brief description of the function of the front panel controls and connectors is contained in the following subsections. Refer to Figure 2.1.

2.3.1 DC POWER Key Switch and Output Range Selection

A three position key switch on the front panel of the LDX-3620 controls the power to the current source circuits:

* Off ..... center position
* 200 mA ..... 1/8 turn clockwise (CW)
* 500 mA ..... 1/8 turn counter-clockwise (CCW)

The front panel power key switch operates independently of the rear panel AC POWER switch. The rear panel switch controls only AC-line-power/battery-charge operation. With the rear panel switch turned on, the power LED above the front panel key switch will light up, indicating that AC power is on and that the batteries are charging.

2.3.2 Low Battery Indication and Shutdown

A "B" indicated on the display of the LDX-3620 means that the batteries should be recharged. Repeated operation of the unit to the point where the low battery "B" is indicated greatly reduces the battery life and is not recommended. See Section 4.2 for recommended battery maintenance.

If the batteries continue to be discharged after the low battery "B" indicator appears, shutdown circuits may turn off the output of the LDX-3620. Shutdown is indicated on the display when all of the decimal points are displayed. Use of the instrument will be disabled until the batteries have been recharged and the DC POWER key switch has been turned off and then on again.

2.3.3 EXT Modulation

An external voltage wave form can be used to modulate the LDX-3620 output when the modulation mode selection switch is set to either the EXT AC or EXT DC positions. The external signal is input through the front panel EXT BNC jack and is AC or DC coupled according to the mode switch position. The transconductance of the instrument is determined by the output current range selected by the DC POWER key switch; it is 100 mA/V in the 200 mA output range, or 250 mA/V in the 500 mA output range. Under all modes of operation, the output is clipped at the level set by the current LIMIT knob.

2.3.4 RAMP Modulation

The LDX-3620 output can be modulated using the internal ramp generator when the MODULATION selector switch is set to the RAMP position. The ramp period is variable between 50 mSec and 100 Sec via the RAMP PERIOD adjustment pot. The ramp peak-to-peak amplitude is adjusted using the RAMP SPAN front panel pot. A DC offset may be added to the ramp by using the OUTPUT ADJUST knobs.

Ramp fly-back time is approximately 700 microseconds. The ramp wave form will be clipped, should it try to exceed the current limit.

2.3.5 MODE Selector

The front panel MODE switch selects the feedback mode of the LDX-3620. In CONST CURRENT mode, the LDX-3620 is a voltage controlled current source that delivers a current proportional to the sum of the MODULATION section and OUTPUT ADJUST knob control signals.

In the CONST POWER mode, the LDX-3620 uses the photodiode feedback signal to determine how much current should be output to the laser or LED to maintain a constant light power. The output current increases until the photodiode feedback current equals a value proportional to the control signal set by the MODULATION and the OUTPUT ADJUST sections on the front panel. If the control signal is a DC level, then the output **optical power** is held constant. If the control signal is modulated, then the output **optical power** is modulated, so long as the bandwidth of the modulation is held below 20 Hz. Modulation frequency components higher than 20 Hz are attenuated, and the modulation becomes a mixture of optical-power modulation and current modulation.

2.3.6 LIMIT Current Adjustment

The LIMIT knob on the front panel sets the output current limit level. Setting this knob fully clockwise (CW) limits the LDX-3620 output current to 500 mA. Setting it fully counter-clockwise (CCW) limits the output to approximately 10 mA. **The current limit is active in all operating modes of the LDX-3620.** A more complete description of how to set current limit may be found in Section 2.5.8.

2.3.7 OUTPUT On/Off

The current output of the LDX-3620 is shorted by a mechanical switch and a JFET when the front panel OUTPUT push button switch is in the OFF/SHORT position (out). When the OUTPUT switch is set to the ON position, the short is removed and the JFET is turned off slowly. This brings the output current up slowly to the level determined by the OUTPUT ADJUST and MODULATION control signals.

When the output is shorted internally, the OUTPUT SHORT LED on the front panel will light up.

2.3.8 OUTPUT ADJUST Controls

The OUTPUT ADJUST, COARSE, and FINE knobs set the DC output level of the LDX-3620. The DC bias level is summed with the control signals derived from the MODULATION section to determine the final output level.

2.3.9 DISPLAY Selector

The display of the LDX-3620 indicates the average output current of the unit when the DISPLAY push button switch is in the LASER position (out). It displays the average photodiode feedback current input to the rear panel when the DISPLAY switch is in the MONITOR position (in).

> **Note: When in the MONITOR position (in), the display reads the negative value of the average photodiode current. This reminds the user that the display switch is in the MONITOR position.**

2.3.10 Output 4-1/2 Digit LCD Display

The LDX-3620 output current and monitor photodiode current are displayed on a 4-1/2 digit liquid crystal display on the front panel of the instrument. When the DISPLAY push button is in the LASER position (out), the display reads the average current setting determined by the MODULATION and OUTPUT ADJUST controls. It does so even when the OUTPUT push button is in the OFF/SHORT position (out) and no current is delivered to the output. The resolution of the display depends on the range selected by the DC POWER key switch: 0.01 mA in the 200 mA setting and 0.1 mA in the 500 mA setting.

When the DISPLAY switch is in the MONITOR position (in), the display reads the (negative) average photodiode current input to the rear panel photodiode feedback inputs in milliamperes. This reading is negative to remind the user that the display is in the MONITOR position. The resolution of the display in MONITOR mode does not change with the output range selected by the DC POWER key switch.

The display also announces low battery charge by indicating a "B".
If "low battery shutdown" occurs, the display reads zero current and all of the decimals are displayed (see Section 2.3.2).

2.3.11 OUTPUT SHORT Indicator

The green OUTPUT SHORT lamp lights up when the output is shorted by setting the OUTPUT on/off switch to the OFF/SHORT position (out). It is unlit when the OUTPUT is ON.

2.3.12 OUTPUT ERROR Indicator

The red OUTPUT ERROR indicator lights up when:

* The output has reached the current LIMIT level, set by the LIMIT adjustment.

* The output circuit is open.

* The maximum compliance voltage of the LDX-3620 is insufficient to drive the load.

Table 2.1 lists the possible conditions leading to a lighted OUTPUT ERROR LED:

OUTPUT ERROR CONDITIONS

Condition	Indicated By
Current Limit	* OUTPUT ERROR LED is lit * Display reads value of LIMIT current
Open Circuit	* OUTPUT ERROR LED is lit * Display reads zero
Compliance Voltage Exceeded	* OUTPUT ERROR LED is lit * Display reads a non-zero value less than the LIMIT current

Table 2.1 OUTPUT ERROR Conditions

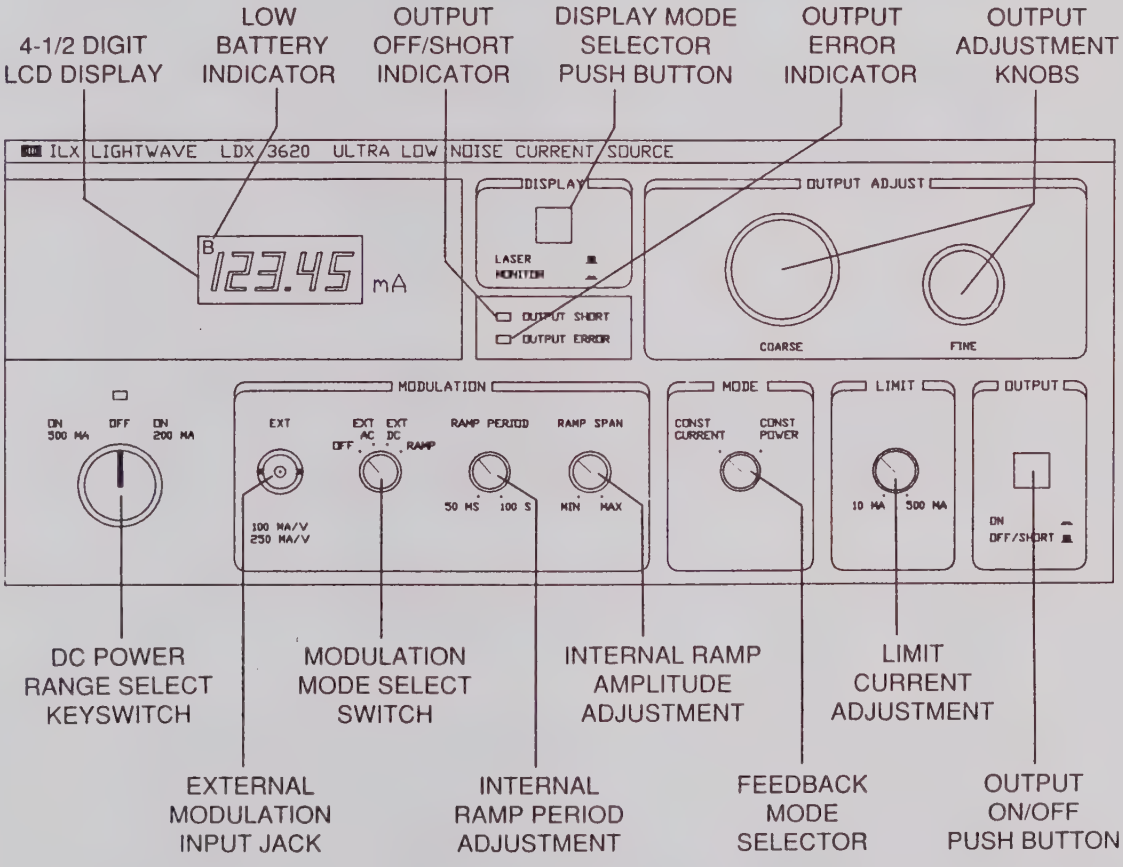


Figure 2.1 LDX-3620 Front Panel

2.4 Rear Panel Controls and Connectors

The following sections contain brief descriptions of the functions of the rear panel controls and connectors. Refer to Figure 2.2.

2.4.1 HIGH/LOW BANDWIDTH Selector

The BANDWIDTH selector switches a 0.1 uF capacitor in and out of the output circuit. This capacitor is connected directly across the output current posts. The capacitor is connected when the LOW bandwidth position is selected, and it is disconnected when the HIGH bandwidth position is selected.

In the HIGH position the modulated output bandwidth of the LDX-3620 is 1 MHz. With the switch in the LOW position the bandwidth across a 100 ohm load is cut to about 20 kHz. The LOW setting decreases noise and prevents oscillation of the LDX-3620 when it is connected to an inductive load, such as a bias "tee" circuit. This allows external modulation of the laser diode using the LDX-3620 as a bias current supply.

2.4.2 OUTPUT Connector (J401)

The rear panel 9-pin D-sub connector (J401) pin-outs are shown in Figure 2.3. The LDX-3620 output current is sourced (+) from pins 8 and 9 and the current returned (-) to pins 4 and 5. The monitor photodiode feedback current is input to pin 7 (+) and returned from pin 6 (-). The feedback leads should be shielded with an earth-ground shield available on pin 3. Sections 2.5.5 and 2.5.6 contain more detailed information on connections and grounding.

Pins 1 and 2 of the rear panel OUTPUT can be connected to an external safety interlock switch to disable the LDX-3620 current output when the switch is opened. See Section 2.5.4 for instructions on the connection of an interlock switch.

2.4.3 PHOTODIODE Feedback Gain Adjustments

The photodiode feedback circuit gain is adjustable on the rear panel to accept full-scale feedback currents from 20 uA to 1 mA. An eight position switch provides COARSE gain adjustment, while a four-turn trimpot provides FINE adjustment. The adjustment procedure is described in Section 2.5.12.

2.4.4 PHOTODIODE Feedback Input Jack

The photodiode feedback current may optionally be input through a rear panel BNC jack. This jack is connected in parallel with pins 6 and 7 of the rear panel 9-pin D-subminiature connector.

2.4.5 RAMP TRIGger Output Jack

Optically isolated RAMP TRIGGER signals are output through two BNC jacks on the rear panel. The OSCILLOSCOPE output delivers a 200 mV square pulse with rising and falling edges of the pulse synchronized to the end and start of the output current ramp. This output remains high during the ramp flyback time of approximately 700 microseconds.

The OPEN COLLECTOR output is capable of driving a TTL load, but requires an external supply and pull-up resistor. See Section 2.5.7 for connection information.

2.4.6 CHASSIS GROUND Connector

Chassis ground is available on the rear of the unit through a banana jack connected to the LDX-3620 cabinet. When a three-wire line cord with earth-ground is used, the cabinet of the LDX-3620 is connected to the ground lead of the power cord.

2.4.7 AC POWER/Battery Charge Switch

AC line power operation and battery recharge is accomplished by connecting the AC line cord and turning on the AC Power switch on the rear panel. With this switch turned off, the LDX-3620 draws power from its internal battery supply. For lowest noise operation, the AC POWER switch should be OFF and the AC power cord disconnected.

2.4.8 Fuse Holder

The AC line fuse holder is on the rear panel. See Section 4.5 for fuse replacement information.

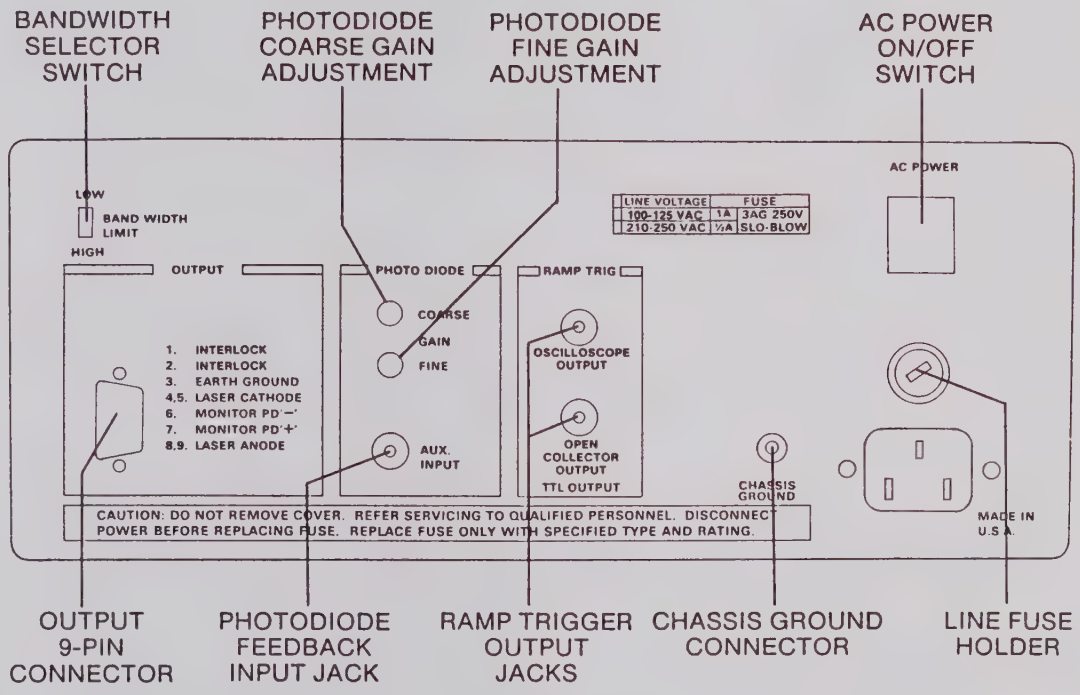


Figure 2.2 LDX-3620 Rear Panel

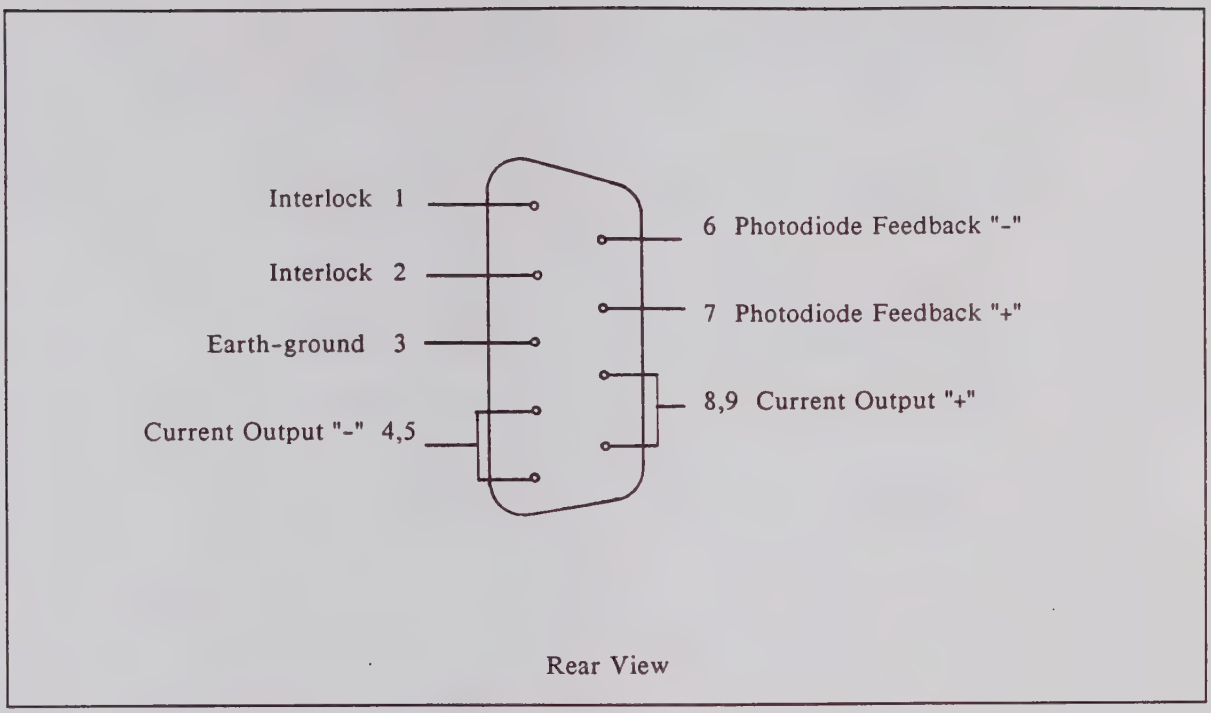


Figure 2.3 Output Connector Pin-out

2.5 LDX-3620 Operation Procedures

Section 4.2 contains information concerning the battery operation of the LDX-3620. (Briefly: it recommends that the batteries be maintained as fully charged as possible to ensure long battery life.)

This section contains recommended procedures for operation of the LDX-3620 with a laser diode. It assumes that the batteries are adequately charged or that AC power is connected and on.

2.5.1 Outline of Operation

Operation of the LDX-3620 can be outlined briefly:

1) Set controls to a safe configuration (see Table 2.2) before connecting the laser and turning on the DC POWER key switch.

2) Connect the laser using one of the recommended shielding schemes (Figure 2.4). Be sure connections are secure and not prone to open should the cables be jostled or bumped (Section 2.5.5). Refer to Section 2.5.6 for photodiode feedback connections.

3) Leave the OUTPUT switch in the OFF/SHORT position (out). Turn on the DC power to the appropriate range and adjust the current LIMIT to a safe level for the particular laser being used (Section 2.5.8).

4) In CONST CURRENT mode, adjust the output current to the desired level with the OUTPUT ADJUST and/or MODULATION controls and turn ON the OUTPUT (in).

5) In CONST POWER mode, adjust the photodiode feedback gain to get maximum resolution on the OUTPUT ADJUST knobs. Then set the output power level with the OUTPUT ADJUST knobs.

6) Before turning off the DC POWER key switch, set the OUTPUT switch to the OFF/SHORT position (out).

7) Recharge the batteries by connecting the LDX-3620 to the AC line, and turn on the rear panel AC POWER switch.

The procedures for each of these steps are contained in the following subsections.

2.5.2 Load Considerations

The LDX-3620 is intended as a current source for laser diode and LED loads. When it is used with a resistive load, the resistance value of the limiting resistor should be selected so that the compliance voltage is not exceeded. For example, a laser diode which has a voltage drop of 1.8 volts may be connected in series with a limiting resistor. If the 200 mA range is selected on the LDX-3620, the guaranteed compliance voltage is +5 volts. If the current LIMIT is set to 100 mA, the maximum resistance value can be found by Ohm's Law:
(R = E / I) 3.2 V / 0.1 A = 32 ohms.

If the LDX-3620 is to be used with an inductive load, such as a bias "tee" network, the LOW BANDWIDTH setting should be used. This is done to prevent possible oscillation of the LDX-3620.

IMPORTANT

If the LDX-3620 is to be connected to an inductive load, such as a bias "tee" network, the LOW BANDWIDTH setting (on the rear panel) should be used. This is necessary to prevent oscillation of the LDX-3620.

2.5.3 Safe Settings

Before turning the DC power on, the front panel controls should be set to a safe configuration. Table 2.2 lists the recommended settings.

RECOMMENDED SAFE SETTINGS

Front Panel Control	Recommended Setting
OUTPUT switch:	OFF/SHORT (out)
MODE knob:	CONST CURRENT
MODULATION knob:	OFF
DISPLAY switch:	LASER (out)
OUTPUT ADJUST knobs:	Fully counter-clockwise (CCW)
LIMIT knob:	Fully counter-clockwise (CCW)

Table 2.2 LDX-3620 Recommended Safe Initial Settings

2.5.4 Safety Interlock Connections

A safety interlock connection is available on pins 1 and 2 of the LDX-3620 rear panel OUTPUT connector. These pins must be shorted to enable the LDX-3620 current output. When this circuit is opened, the interlock turns off the current output, and the OUTPUT SHORT indicator lights up. Then when the circuit is re-closed, the output turns on slowly in the same manner as when the front panel OUTPUT push button switch is turned ON (in).

To use the interlock feature, the user must provide wires connected from the OUTPUT connector interlock pins to a normally closed, external, user supplied switch or relay. These connections must be electrically isolated from all other circuits.

The interlock pins are shorted together inside the hood of the mating male, 9-pin D-sub output connector supplied with the LDX-3620.

2.5.5 Laser Diode Connections and Shielding

IMPORTANT

Before connecting the laser diode to the LDX-3620, be sure that the front panel OUTPUT switch is in the OFF/SHORT position (out). Before turning the OUTPUT on, be sure that the current LIMIT has been correctly set.

The LDX-3620 output is available through the 9-pin rear panel OUTPUT connector J401 (see Figure 2.3). The LDX-3620 sources current through pins 8 and 9 to the laser anode (+) and returns current from the cathode (-) through pins 4 and 5.

IMPORTANT

The cable connections to the laser must be secure enough that they won't open-circuit, should they be jostled or bumped. Should an open circuit occur during laser operation, DO NOT attempt to remake the circuit until the front panel OUTPUT switch has been released to the OFF/SHORT position (out). Remaking the circuit with the OUTPUT on will expose the laser to the maximum compliance voltage of the LDX-3620, which will probably result in laser damage.

A laser will probably be damaged if an open circuit occurs during laser operation while the output is on. The damage is caused by a momentary circuit break-and-remake, before the final circuit break. Therefore, always make sure that the cabling is secure. An open circuit is indicated by the front panel OUTPUT ERROR lamp and a zero current reading on the display.

If the LDX-3620 is to be used in CONST POWER mode, the photodiode feedback current should be sourced to pin 7 (+) and returned from pin 6 (-) of the rear panel 9-pin connector. Alternatively, the feedback current can be connected through the rear panel AUX. INPUT BNC connector, using the center conductor of the co-ax for the "+" connection, and the outer shield conductor for the "-" connection.

It is recommended that the connections to the LDX-3620 output be made by using twisted wire pairs, with an earth grounded shield, as shown in Figures 2.4 A through D. The output conductors are left floating, relative to earth-ground, to suppress AC power-on/power-off transients that may occur through an earth-ground return path. If the output circuit is earth-grounded at some point (such as through the laser package and mount), then the user must be careful to avoid multiple earth-grounds in the circuit. Multiple earth-grounds may provide circuit paths that induce spurious currents in the photodiode feedback circuit and output leads.

2.5.6 Photodiode Feedback Connections

Many laser diode modules contain an internal photodiode that monitors the back-facet emission of the laser. This photodiode is usually internally connected to either the laser anode or cathode. Figures 2.4 A through D show the recommended connections and shielding for the various configurations of laser diode modules and photodiode feedback schemes.

The feedback photodiode reverse-biasing supply shown in these figures must be supplied by the user. It is located in the circuit where it will not cause the common mode voltage of the feedback inputs to exceed their specified maximum of ±6 volts, relative to the "-" current output terminal (pins 4 and 5 of J401). Noise from this biasing supply may contribute to the output noise levels; therefore, a battery with shielded connections is recommended.

If a feedback photodiode is used, which is electrically isolated from the laser, the feedback circuit must be resistively "tied" at some point to the output circuit. A large resistance of 1 Mohm, connected from the laser cathode to the photodiode anode, may be used in place of the direct connection (see Figure 2.4B). This is done to keep the feedback inputs within the specified maximum ±6 volt common mode voltage, relative to the "-" laser current output (pins 4 and 5 of J401). The circuit of Figure 2.4B should be used, if feasible.

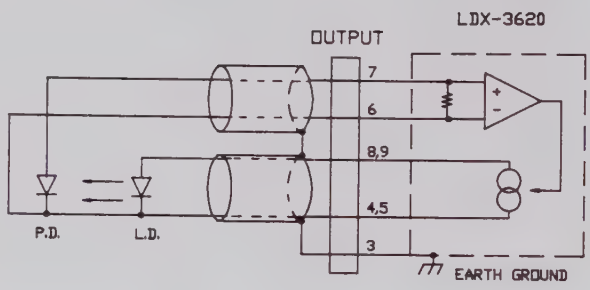
2.5.7 RAMP TRIGger Output Connections

Two optically isolated RAMP TRIGGER outputs are provided on the LDX-3620 rear panel. The OSCILLOSCOPE output provides a voltage square pulse of up to 200 mV amplitude that is synchronized to the start and end of the output current ramp. The falling edge of the voltage pulse signals the start of the output current ramp. The rising edge signals the end of the ramp. This output remains high during the approximately 700 microsecond ramp flyback. The OSCILLOSCOPE output should be connected to an instrument with an input impedance greater than 100 Kohms.

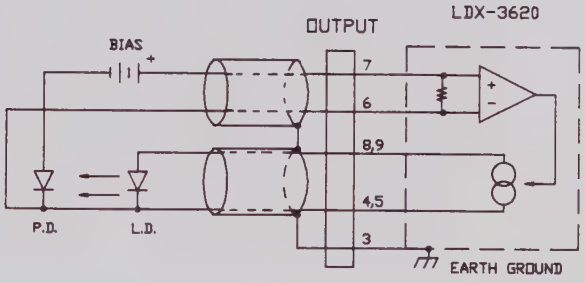
The OPEN COLLECTOR output may be used to drive TTL circuits, but requires an external supply and pull-up resistor. This output "turns off" (stops conducting) at the beginning of each ramp cycle. It "turns on" (starts conducting) at the end of the current ramp. It remains "on" during the approximately 700 microsecond ramp flyback time. The pull-up voltage must be less than 25 volts, with the center conductor positive relative to the BNC shell. When "on" the OPEN COLLECTOR output sinks up to 10 mA. The "on" state power dissipation should be limited to 100 mW.

IMPORTANT

The OSCILLOSCOPE and OPEN COLLECTOR outputs cannot be used at the same time.

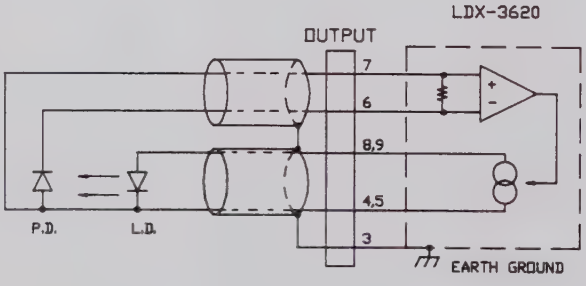


PHOTOVOLTAIC MODE

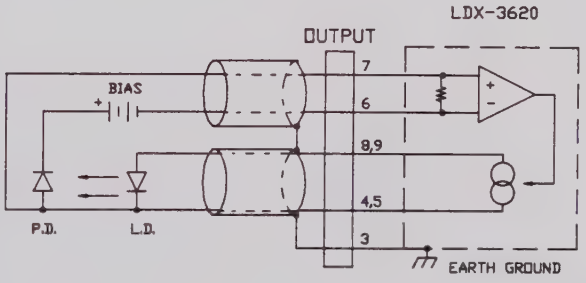


PHOTOCONDUCTIVE MODE

Figure 2.4A Common Laser Cathode - Photodiode Cathode



PHOTOVOLTAIC MODE



PHOTOCONDUCTIVE MODE

Figure 2.4B Common Laser Cathode - Photodiode Anode

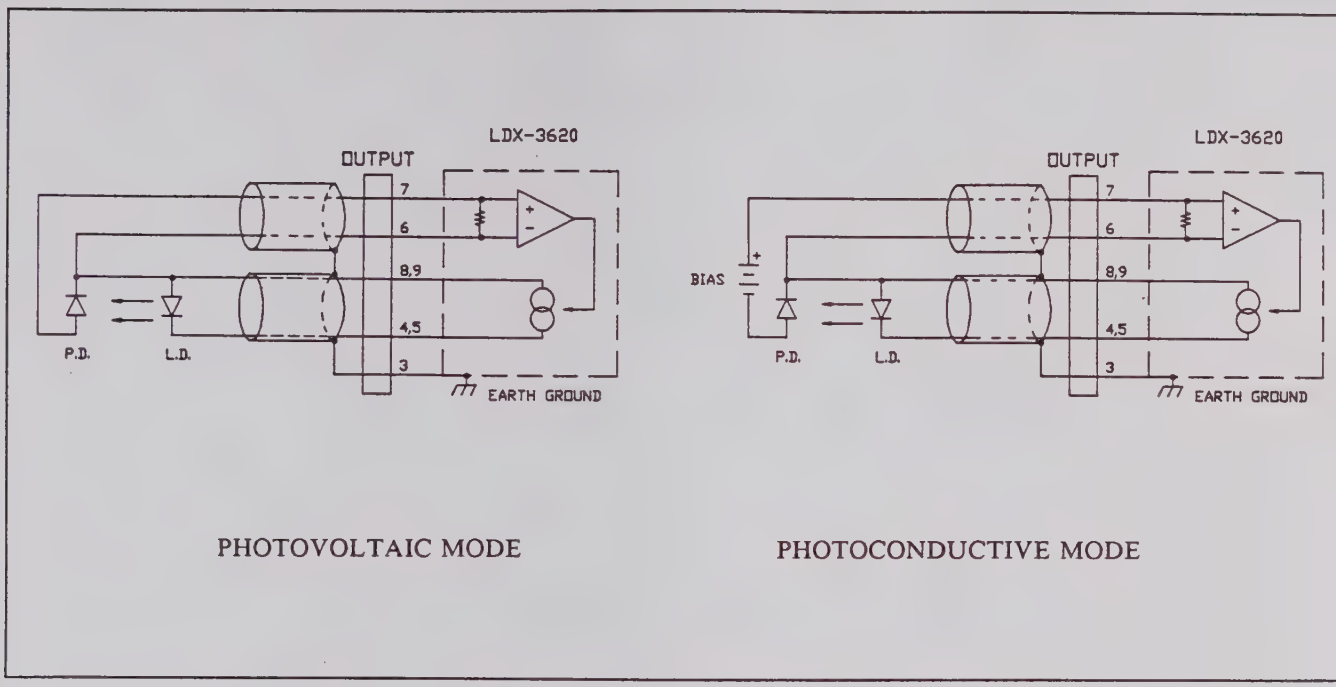


Figure 2.4C Common Laser Anode - Photodiode Cathode

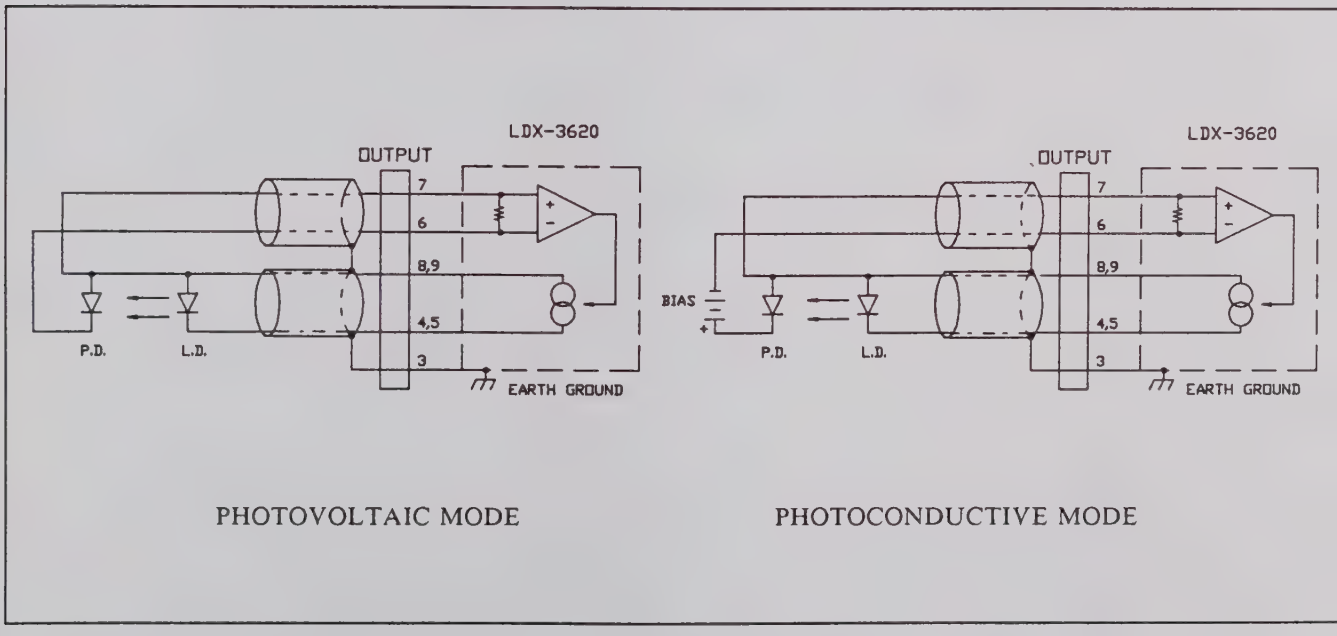


Figure 2.4D Common Laser Anode - Photodiode Anode

2.5.8 Setting the LIMIT Current

Once the "safe" settings have been made (see Table 2.2), the output current LIMIT should be adjusted to a safe level for the particular laser diode being used. (Refer to the max. current rating for your laser diode.)

1) Set the OUTPUT switch to the OFF/SHORT position (out); the OUTPUT SHORT LED should light up.

2) Set the DISPLAY push button switch to the LASER position (out).

3) Turn the COARSE output adjust knob to its maximum setting, fully clockwise (CW). The OUTPUT ERROR indicator should light up.

4) Adjust the LIMIT knob until the display reads the desired limit current.

5) Return the COARSE output adjust knob to its minimum setting, fully counter-clockwise (CCW). The OUTPUT ERROR indicator should be unlit.

2.5.9 Setting the Output in CONST CURRENT Mode

Before adjusting the output current of the LDX-3620 with the OUTPUT ADJUST knobs or the MODULATION controls, be sure that the current LIMIT has been properly set (Section 2.5.8) and that the laser circuit connections are secure. With that done:

1) Set the DISPLAY push button switch to the LASER position (out).

2) Adjust the COARSE and FINE output adjust knobs until the display reads the desired output current level.

3) Push the OUTPUT switch to the ON position (in).

The displayed current is being delivered to the load.

2.5.10 Setting the MODULATION Controls

The current output of the LDX-3620 can be controlled by an external voltage waveform. The transfer function of the modulation is 100 mA/V when the 200 mA output range is selected with the DC POWER key switch, or 250 mA/V when the 500 mA range is selected. The output current waveform should be monitored with an oscilloscope (connected across a resistor in series with the load) when making adjustments. The current LIMIT circuit may clip the output waveform. Also, trying to drive a negative current will cause the output stage internally to go to the rail. In that case, the output is slew rate-limited when the

control voltage goes positive and tries to drive a positive current output. This can cause a non-linear output waveform. However, this will not cause a negative current to flow in the laser diode.

1) Connect the external modulation signal to the front panel EXT input BNC jack.

2) Select AC or DC coupling of the input with the corresponding position of the MODULATION selector knob.

3) Push the OUTPUT switch to the ON position (in).

4) Set any desired offset DC output current with the OUTPUT ADJUST knobs.

The output current is the sum of the level set by the OUTPUT ADJUST knobs and the current programmed by the modulation signal. The display reads the average current delivered to the load.

2.5.11 Using the Internal RAMP Generator

When the MODULATION selector switch is in the RAMP position an internal ramp generator modulates the output current with a linear ramp waveform. Adjustments of the ramp span and period should be made while using an oscilloscope to monitor the output current (i.e. voltage drop across a resistor in series with the load). The current LIMIT circuit may clip the output waveform.

1) Set the MODULATION selector switch to the RAMP position.

2) Push the OUTPUT switch to the ON position (in).

3) Adjust the period of the ramp with the RAMP PERIOD knob.

4) Adjust the peak-to-peak amplitude of the ramp with the RAMP SPAN knob.

5) Set any desired offset DC output current with the OUTPUT ADJUST knobs.

The display reads the average current delivered to the load.

2.5.12 Setting the Photodiode Feedback Gain

The gain of the photodiode feedback circuit should be adjusted before operating the LDX-3620 in CONST POWER mode.

IMPORTANT

The LIMIT current level MUST be correctly set before switching the MODE selector to CONST POWER and turning the OUTPUT switch ON (in). Laser damage will result if the current level is not safely set. See Section 2.5.8 for setting the LIMIT current.

1) Set the front panel controls to the safe initial settings of Table 2.2.

2) Check that the LIMIT current is correctly set (see Section 2.5.8).

3) Using a small, flat blade, alignment screwdriver, set the COARSE photodiode feedback gain adjustment to its maximum setting. (If an improper tool is used, you may damage the nylon screw head).

   Turn the COARSE adjustment to the vertical position. (The screwdriver blade will be horizontal. This is minimum gain.) Then turn it one more click counter-clockwise (CCW) to the maximum gain setting. Refer to Figure 2.5 for the gain switch setting.

The FINE gain adjustment need not be adjusted at this time.

4) Turn the front panel OUTPUT ADJUST knobs to their minimum settings, fully counter-clockwise (CCW).

5) Turn the front panel MODE selector to the CONST POWER position.

6) Push the OUTPUT switch to the ON position (in).

   If the OUTPUT ERROR LED does not light up at this point in the procedure, continue on to Step 8.

   If at this point the OUTPUT ERROR LED lights up and indicates a current limit condition, turn off the output and check that all connections are correctly made, and that the rear panel feedback gain adjustments are at their maximum settings. Retry Step 6.

7) Carefully increase the output level by slowly turning the OUTPUT ADJUST knob clockwise (CW) until the desired maximum output operating level has been reached. When the desired level has been reached, proceed to Step 8.

   If the desired output level cannot be reached with the COARSE output adjust knob turned fully clockwise, then:

   a) Turn the OUTPUT ADJUST knobs fully counter-clockwise (CCW) again.

   b) Set the OUTPUT switch to the OFF/SHORT position (out).

c) Decrease the photodiode feedback gain by turning the COARSE gain switch one more click counter-clockwise (CCW).

d) Push the OUTPUT switch to the ON position (in).

e) Repeat Step 7.

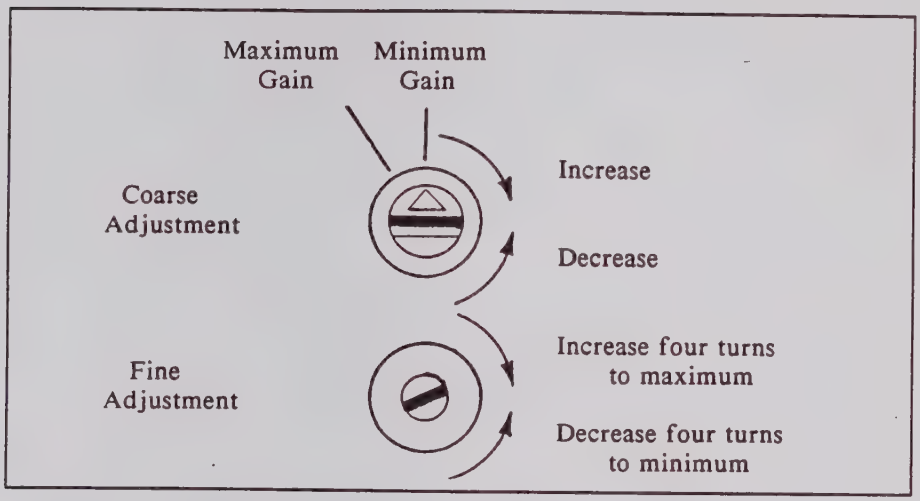


Figure 2.5 Photodiode Gain Adjustments

8) By alternately increasing the COARSE and FINE OUTPUT ADJUST knob settings and decreasing the FINE photodiode feedback gain trimmer, a full scale setting of the OUTPUT ADJUST knobs (both fully clockwise) can be made to deliver the desired maximum output power level. If this cannot be accomplished using the FINE gain adjustment trimmer, one more repetition of Step 7 may be required.

9) Push the DISPLAY switch to the MONITOR position (in) to display the photodiode current.

NOTE - When in the MONITOR position the display reads the negative value of the average photodiode current. This reminds the user that the display push button switch is in the MONITOR position (in).

10) Adjust the MODULATION and OUTPUT ADJUST controls to set the desired output optical power levels.

2.5.13 Setting the Laser Power in CONST POWER Mode

Whenever the MODE selector switch is in the CONST POWER position, the LDX-3620 maintains the output **optical power** in proportion to the control signals derived from the MODULATION and OUTPUT ADJUST sections of the front panel. After the photodiode feedback gain has been successfully adjusted, the output **optical power** level can be set:

1) Set the OUTPUT switch to OFF/SHORT (out).

2) Turn the MODE selector to CONST POWER.

3) Press the DISPLAY switch to the MONITOR position (in).

When in the MONITOR position, the display will read the negative value of the average photodiode current.

4) Press the OUTPUT switch to the ON position (in).

5) Adjust the MODULATION and OUTPUT ADJUST front panel controls as in CONST CURRENT mode, but keep in mind the following:

   * The output **optical power** of the laser is proportional to the MODULATION and OUTPUT ADJUST control signals to the extent that the photodiode feedback current is proportional to the output optical power. Therefore, if proportionality of **optical power** to the control signals is important, the photodiode should be used in a reverse biased photoconductive mode. If **optical power** stability alone is required, then using the feedback photodiode in a photovoltaic mode should suffice.

   * In CONST POWER mode, AC MODULATION components higher than about 20 Hz are attenuated, and the resulting modulation is a combination of current-modulation and power-modulation.

Chapter 3

THEORY OF OPERATION

3.1 Introduction

This chapter discusses of the theory of operation of the LDX-3620 circuits and refers to the schematics, Figures 3.2, 3.3, and 3.4. Figure 3.1 is a functional block diagram of the LDX-3620.

3.2 Power Supply/Battery Charge

The batteries of the LDX-3620 are trickle charged when the AC line is connected and the AC power switch (S401) is turned on. Half-wave rectifiers in the transformer (T401) secondary circuit form raw ±12 volt power supplies. The raw supplies are regulated by U204 and U205 and are fed through current limiting 1 ohm resistors and back-current blocking diodes to the batteries.

3.3 Low Battery Indication

Op amps U104 and U105 provide an adjustable bipolar power supply for U106. The resistor divider R124 and R125 allows the voltage span to be calibrated such that when the +12 volt battery voltage drops to +11.5 volts, the display driver's (U106) internal low battery detection turns on the "B" indicator on the display.

3.4 Low Battery Shutdown

A further drop of either of the ±12 volt battery voltages below ±11.0 volts is detected by comparators in U201. The comparator then turns off the output current supply, through Q203, and shorts the output by turning on the JFETs Q204-Q206. The output will remain off and shorted until the batteries have been recharged and the DC power switch is turned off and on again.

Low battery shutdown also lights all of the decimal points in the display. A low voltage on pins 1 or 14 of U201 turns on Q103 which forward biases CR107-110, bringing high the decimal point inputs on U107.

3.5 Current LIMIT

The front panel LIMIT pot, R229, adjusts the feedback resistance for U202 and determines the limit current level.

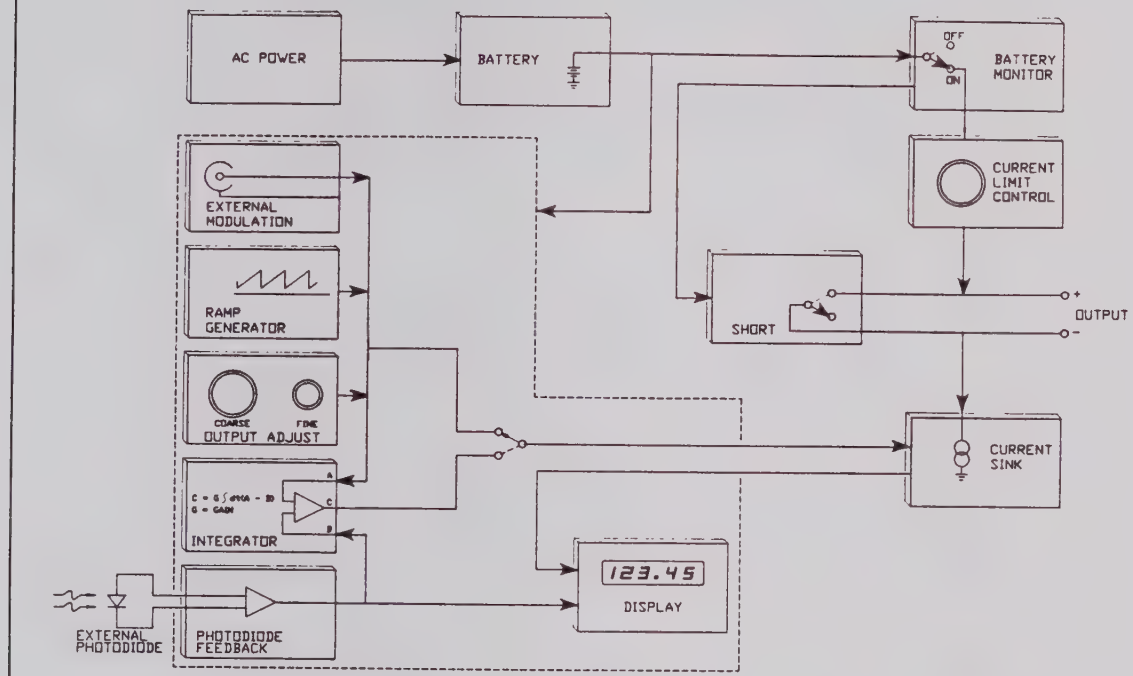


Figure 3.1 LDX-3620 Functional Block Diagram

3.6 Voltage Controlled Current Sink

Op amp U203 and MOSFET Q207 with current sense resistors R218 and R219 comprise a precision voltage controlled current sink in parallel with the LDX-3620 output. The op amp turns on the FET, increasing the sink current until the voltage developed across the feedback resistors equals the control voltage on pin 3 of U203. In the 500 mA output range, feedback resistor R219 is shorted by relay K201. Therefore, the full scale control voltage for the 200 mA and 500 mA output ranges is 2 volts. (200 mA x 10 ohms = 2 volts, or 500 mA x 4 ohms = 2 volts.)

Should the output be on and open-circuited, or the output current be at the set limit level, the voltage at pin 6 of U203 will be at the positive supply rail. This condition is detected by comparator U201:A which lights the front panel OUTPUT ERROR LED.

3.7 Current Display

The voltage developed across the series combination of R218 and R219 is sensed by U106 and displayed with the decimal shifted to give the output current in milliamps in the 200.00 mA range. In the 500.0 mA range the voltage across R218 is divided by R220 and R221, and is used to drive the display.

3.8 Control Voltage in CONST CURRENT Mode

When the MODE switch S102 is in the CONST CURRENT position, the control voltage to the output current sink is connected through the MODULATION switch S101.

3.9 Modulation OFF

When S101 is in the OFF position, the control voltage is the +5 volt reference U101 divided by the COARSE and FINE OUTPUT ADJUST pots (R105 and R104) and the calibration trimmer (Output Span) R103.

IMPORTANT

The lowest noise operation is achieved with the MODULATION set to the OFF position.

3.10 EXT AC Modulation

In EXT AC mode the AC components of the modulation signal input into the front panel BNC jack J102 are fed through C102 and C103 to develop their voltage across the inputs to the differential amplifier formed by U103 and precision resistors R118 through R123. The control voltage set by the OUTPUT ADJUST pots is summed into this circuit also, providing an adjustable DC bias to be set by the user. The transconductance for the modulation input is 100 mA/V for the 200 mA range, and 250 mA/V for the 500 mA output range.

3.11 EXT DC Modulation

DC modulation is accomplished in the same manner as AC modulation except that the modulation input is fed to the differential amplifier directly. The transconductance is the same as in the AC setting.

3.12 Internal RAMP

When S101 is in the RAMP position, op amp U103 sums the voltage at the wiper of R105 (COURSE OUTPUT ADJUST) with the voltage divided output of the ramp generator at the wiper of R117 (RAMP SPAN). This becomes the control voltage for the output current sink.

Op amps U102 A through D comprise the ramp generator. U102:B buffers the 5 volt reference U101 which is inverted to -5 volts by U102:A.

3.13 Ramp Period

Resistors R107 and R106 divide the -5 V reference to a voltage V_i that U102:C integrates, providing a voltage ramp increasing at V_i/(R108 x C101) or about V_i/41.5 volts/second. U102:D allows the ramp to increase until a fixed threshold voltage is reached. The ramp then returns to its starting point, and the cycle restarts. The time it takes the ramp to reach the threshold from its starting point is the ramp period, and is determined by the ramp rise rate set by R106.

During integration, the output of U102:D is at the negative rail which keeps FET Q101 turned off. The voltage on the non-inverting input of U102:D is the ramp voltage divided by resistors R110 and R112. It increases until it exceeds the voltage on the inverting input which is clamped at -0.6 volts by CR102. When this happens, the output of U102:D jumps to the positive voltage rail turning on Q101. This shorts the integrating capacitor C101 and returns the ramp to its starting point.

The output of U102:D remains high until its inverting input is pulled higher than its non-inverting input by the voltage at R111, with a time constant determined by R109 and C101 (about 700 microseconds). When U102:D changes to the negative rail, Q101 turns off to begin the ramp cycle again.

3.14 RAMP SPAN

The RAMP SPAN pot R117 divides the raw ramp output of U102:C to an amplitude set by the user. This is summed with the OUTPUT ADJUST level which sets the DC bias for the ramp.

3.15 RAMP TRIGger Output

The opto-isolator U305 forms the RAMP TRIG outputs. The LED of the opto-isolator is turned on by the output of U102:D during the ramp flyback and reset portion of the ramp cycle. The OSCILLOSCOPE OUTPUT uses the base-collector photocurrent of the opto-isolator transistor to develop a voltage across the 1 Mohm resistor, R303. Therefore, the falling edge of this output signals the start of the current ramp.

The OPEN COLLECTOR output is taken across the collector and emitter of the phototransistor, U305.

3.16 HIGH/LOW BANDWIDTH Selection

The rear panel BANDWIDTH LIMIT selector (S202) switches in and out a 0.1 uF capacitor (C211) connected in parallel with the output. In the LOW setting, C211 is in the circuit to eliminate noise and prevent oscillation.

3.17 Photodiode Feedback Amplifier

Op amps U301:A, U301:C, U301:D and matched resistor network R305 through R308 form a high input impedance differential amplifier. This stage amplifies the voltage developed by the feedback photocurrent (input through the rear panel OUTPUT jack) across the 872 ohm sense resistance. The parallel combination of R301 and R302 form the sense resistance. This buffered voltage is inverted and amplified by U302, forming a monitor voltage supplied to the display through J301.

3.18 Photodiode Feedback Control Signal

The buffered photodiode feedback voltage is inverted and amplified by U301:B with a gain adjustable through eight ranges selected by S301 and trimmed by R325. The gain is adjusted by the user (see Section 2.5.12). Op amp U301:B pulls the voltage at pin 3 of U304 down from the voltage buffered by U303. U304 integrates the sum of the voltages at pin 7 of U301:B and pin 6 of U303 until it reaches zero; this voltage reaches zero when the photodiode current has risen to the level selected by the control voltage buffered by U303. The output of the integrator controls the output current sink when the MODE switch (S102) is in the CONST POWER position.

Transistors Q301 and Q302 disable the integrator when the current OUTPUT is turned off or when the MODE select is set to CONST CURRENT. The gates of these JFETs are turned on slowly to enable the integrator when the OUTPUT is turned on and CONST POWER mode is selected. The integrator is driven to the negative (-) rail to prevent an output spike if the output is turned off and then on.

3.19 Safety Interlock

Pins 1 and 2 of the rear panel 9-pin OUTPUT connector (J401) are used to shut off the LDX-3620 output if an open circuit occurs between these pins. A short between pins 1 and 2 connects R233 to +12 volts; this allows the output-short JFETS to be turned off by providing a pull-up for the open collector comparator (U201:D), so the output is turned on. Removing the short, turns on Q203 which turns on the output-short JFETS, thus turning off the output.

Chapter 4

MAINTENANCE

4.1 Introduction

This chapter discusses the recommended procedures for maintaining the LDX-3620 in good operating condition. Section 4.2 is especially important to read for an understanding of the requirements of the battery operation of the LDX-3620. AC line voltage selection and fuse replacement are covered in Sections 4.4 and 4.5. Section 4.6 contains the procedures for calibrating the LDX-3620. Section 4.7 covers procedures for disassembly of the enclosure. Section 4.8 contains the wiring diagrams for the internal wiring connectors.

4.2 Battery Maintenance

The battery life of the LDX-3620 depends on the frequency and degree of discharge of the batteries during use. With light use and proper maintenance, the batteries should last for more than 1100 recharge cycles (about four years of daily use). With heavy use battery lifetime can be degraded by as much as 60%. This can be improved by adding an extra +12 volt battery, the 3138 "Long Life" option.

The batteries are continuously charged whenever the LDX-3620 is connected to an AC power source and the rear panel AC power switch is turned on. Full recharge of the batteries takes about 8 hours.

The data of Table 4.1 suggest that long battery life results from maintaining the batteries as fully charged as possible and that short battery life will result from the practice of waiting until a low-battery condition is indicated before recharging the batteries.

If the LDX-3620 is to be stored for long periods, the batteries should be fully recharged for eight hours every 6-9 months to prevent a permanent loss of capacity due to self-discharge.

Battery life in recharge cycles can be estimated from Table 4.1 once one calculates the average "amp-hours" drawn from the LDX-3620 between recharges. This is calculated by multiplying the average time the unit is used between recharges by the average output current setting during use. The operation time includes the time when the OUTPUT push button is OFF (out) since turning off the output simply shunts the output current through a short internal to the LDX-3620.

ESTIMATED BATTERY LIFE

Average Amp-hours	Expected Charge/ Recharge Cycles	Recharge Cycles With 3138 Option
1.5	1100	
2.0	700	
2.5	400	1200
3.5	300	700
4.5	200	400
7.0	*	300
9.0	*	200

* Indicates that low-battery shutdown will prevent further discharge at these points.

Table 4.1 Estimated Battery Lifetime

4.3 Battery Replacement

The batteries may be replaced by removing the push-on electrical spade connectors and the sheet-metal tie-downs, which are held in place with 6-32 machine screws. The negative 12 volt supply battery should be replaced by a Power Sonic model PS-1212 lead-acid battery (ILX P/N 597-613-211). The positive 12 volt supply battery is a Power Sonic model PS-1245 (ILX P/N 597-613-251).

4.4 AC Line Voltage Selection

AC line voltage selection is made with jumpers on the primary windings of the power transformer. 100-130 VAC operation is selected by connecting transformer lugs 1 and 5 to the neutral AC line, and lugs 2 and 6 to the "hot" AC line. 210-240 VAC operation is selected by connecting neutral AC line to lug 1, connecting lug 2 to 5 with a jumper, and connecting the "hot" AC line to lug 6.

The transformer lugs are numbered 1 to 6, with lug 1 being nearest the mounting legs on the side-rail of the LDX-3620. The transformer wiring is accessed by removing the bottom pan of the instrument. See Figure 4.1 for the correct AC line connections.

4.5 Fuse Replacement

The AC power fuse is located on the rear panel of the LDX-3620. Should replacement be necessary, first disconnect the power cord and turn the AC POWER switch OFF. Refer to Table 4.2 for the correct fuse ratings.

FUSE REPLACEMENT GUIDE

Line Voltage	Replacement Fuse
100-130 VAC	1 Amp, 3AG, Slow Blow
210-250 VAC	1/2 Amp, 3AG, Slow Blow

Table 4.2 Fuse Replacement

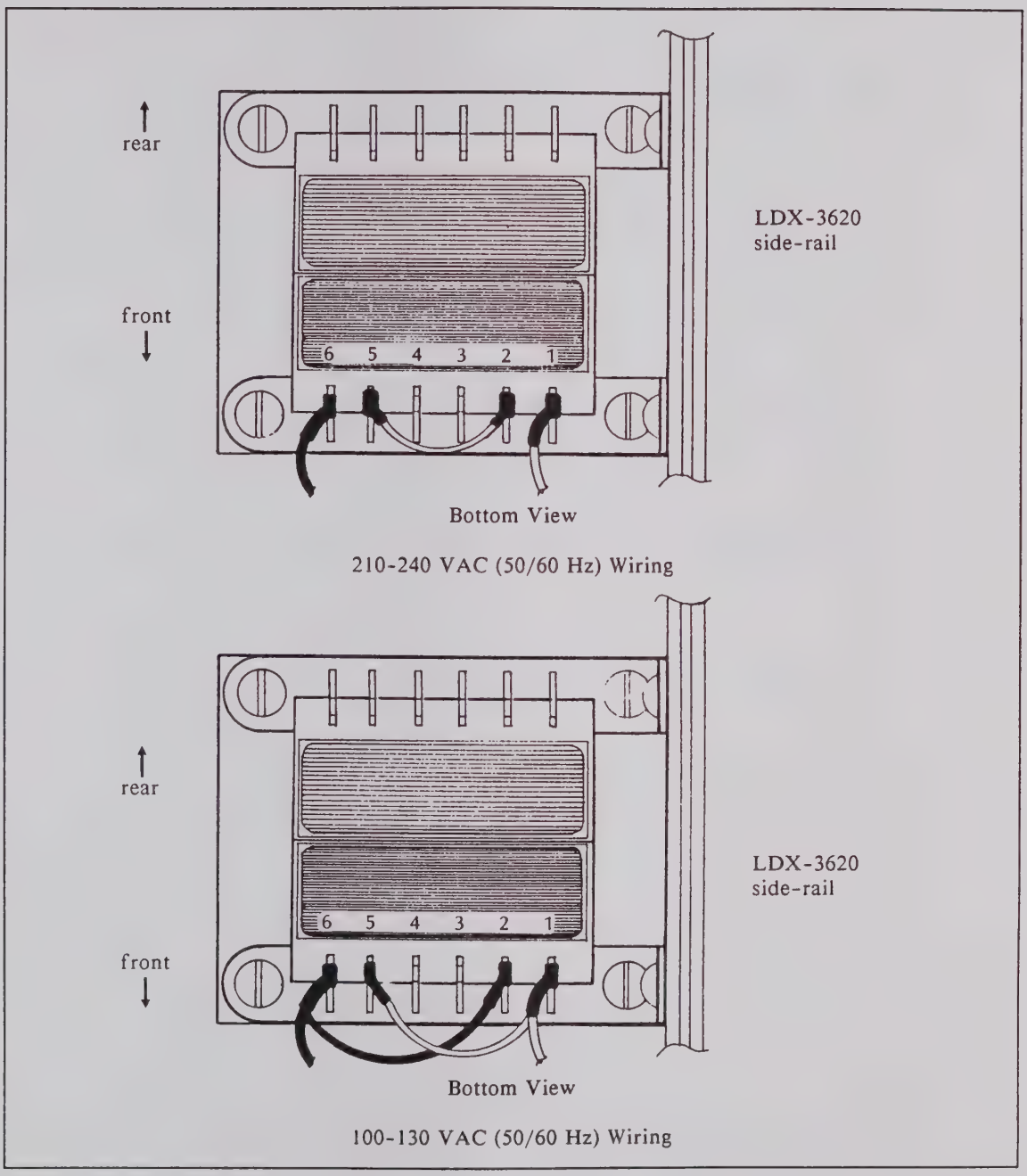


Figure 4.1 Power Transformer Wiring

4.6 Calibration

Sections 4.6.1 through 4.6.5 outline the procedures for calibrating the front panel controls. Access to the adjustment trimpots on the circuit boards will require that the top of the instrument be removed. See Section 4.7 for the removal procedure.

The equipment required for the calibration procedures must be capable of: measuring a current of 500 mA to an accuracy of approximately 0.01 mA, and measuring 1 mA to an accuracy of 0.00005 mA. A good digital multimeter with 5-1/2 digit resolution is usually adequate for this purpose. An oscilloscope is needed to calibrate the RAMP SPAN of the internal ramp generator.

IMPORTANT

Calibration of the LDX-3620 should be performed only by qualified personnel. Potentially lethal or harmful voltages are present and exposed when the top of the unit is removed.

Refer to the component layout diagrams, Figures 3.5 through 3.7, to find the locations of the adjustment trimpots referred to in these procedures.

4.6.1 Display Calibration

Connect the ammeter across the current output of the LDX-3620 to monitor the output current. Make the following settings and adjustments:

1) Release the DISPLAY push button to the LASER position (out).

2) Turn the MODULATION mode selector switch to the OFF position.

3) Set the MODE select switch to CONST CURRENT.

4) Turn the current LIMIT knob fully clockwise (CW) to its maximum setting.

5) Turn ON the DC POWER key switch clockwise (CW) to the 200 mA range.

6) Push the OUTPUT switch to its ON position (in).

7) Turn the output adjust knobs clockwise (CW) until the calibration ammeter reads 200.00 mA.

8) Adjust trimpot R133 (on the front panel board) until the display reads 200.00 mA.

9) Turn the DC POWER key switch counter-clockwise (CCW) to the 500 mA range setting and adjust the OUTPUT ADJUST knobs until the calibration ammeter reads 500.0 mA.

   If the output cannot be adjusted to 500.0 mA at this point, then turn the OUTPUT ADJUST knobs fully clockwise to their maximum settings. Alternately adjust LIMIT pot R229 and trimmer R103 (located near the OUTPUT switch on the front panel board) until the output reaches 500.0 mA according to the following guidelines:

   a) If the OUTPUT ERROR indicator is lit, adjust LIMIT pot R229 to increase the output current until the calibration ammeter reads 500.0 mA or continue adjustment a few turns after the OUTPUT ERROR indicator turns off. If the output current has reached 500.0 mA, proceed to Step 10. If not, proceed to Step 9b.

   b) If the OUTPUT ERROR indicator is unlit, adjust R103 to increase the output current until the calibration ammeter reads 500.0 mA or continue adjustment a few turns after the OUTPUT ERROR indicator lights. If the output current has reached 500 mA, proceed to Step 10. If not, proceed to Step 9a.

10) Adjust R221 (located at the top rear of the side panel board) until the display reads 500.0 mA.

4.6.2 MONITOR Current Display Calibration

When the DISPLAY push button is in the MONITOR position, the display reads the (negative) value of the current input to the photodiode feedback pins 6 and 7 of the rear panel 9-pin connector (J401).

1) After the display has been calibrated (see Section 4.6.1), the LDX-3620 can be used to source 1 mA to the series combination of the photodiode feedback input and calibration ammeter. Make the following connections:

   a) Connect the positive terminal of the calibration ammeter to pin 9 of the rear panel OUTPUT connector (J401).

   b) Connect the negative terminal of the calibration ammeter to pin 7 of the OUTPUT connector (J401).

   c) Connect pin 6 to pin 5 of the OUTPUT connector (J401).

Select the 200 mA current range with the DC power key switch, and set the Output current to 1.00 mA with the OUTPUT ADJUST knobs.

2) Push the DISPLAY push button to the MONITOR position (in).

3) Adjust R320 (on the rear panel board) until the calibration ammeter and the LDX-3620 display readings are the same.

4.6.3 OUTPUT ADJUST Calibration

After the display has been calibrated the OUTPUT ADJUST span can be calibrated:

1) Repeat the settings of Steps 1-6 of Section 4.6.1.

2) Turn the OUTPUT ADJUST knobs fully clockwise (CW) to their maximum setting.

3) Adjust R103 (located on the OUTPUT side of the front panel board) until the calibration ammeter reads 200.0 mA.

4.6.4 LIMIT Current Calibration

The current LIMIT knob must be calibrated to 500 mA at its maximum setting:

1) Repeat the settings of Steps 1-4 of Section 4.6.1.

2) Turn the OUTPUT ADJUST knobs fully clockwise to their maximum settings.

3) Turn the DC POWER range key switch counter-clockwise (CCW) to the 500 mA position.

4) Adjust LIMIT pot R229 until the output current reaches 500 mA.

4.6.5 RAMP SPAN Calibration

An oscilloscope is necessary to monitor the output current waveform in order to calibrate the RAMP SPAN adjustment.

1) Turn the DC POWER key switch counter-clockwise (CCW) to select the 500 mA range. Set the output current LIMIT to 201.0 mA using the procedure described in Section 2.5.8.

2) Turn the OUTPUT ADJUST knobs fully counter-clockwise (CCW) to their minimum setting and change the output current range to 200 mA with the DC power key switch.

3) Connect an oscilloscope to a resistor load connected across the LDX-3620 current output.

4) Turn the modulation mode selector switch to the RAMP position.

5) Turn the RAMP SPAN adjustment knob fully clockwise (CW) to its maximum setting.

6) Increase the ramp amplitude (with trimmer R116 (located near the center of the front panel board) until clipping of the output by the current limit circuit at the ramp maximum can be seen on the oscilloscope. Reverse the adjustment to the point where the clipping just disappears.

4.7 Disassembly

The top cover of the LDX-3620 can be removed after extracting the two countersunk screws on the sides of the instrument near the rear panel. The cover is then removed by sliding it rearward and lifting it off. The bottom of the instrument is removed in a similar fashion.

To remove the front panel of the LDX-3620:

1) Remove the top of the unit.

2) Peel out the decorative plastic inserts in the sides of the front panel bezel to expose four screws on each side.

3) Extract the upper and lower pan-head screws, and loosen the two center flat-head screws.

4) Remove the front panel by pressing gently outward against the circuit board near its mounting screws.

To replace the front panel, reverse the preceding procedure.

4.8 Wiring Diagrams

The following wiring diagrams are provided to assist the user in tracing circuit connections. Refer to the component layout diagrams (Figures 5.1 - 5.3) for the connector locations.

Ident.	Connector/Location	Type/Color	Connector/Location
	J301/Const Power Bd	Ribbon	J102/Display Bd
	Pin #		Pin #
	1		1
	2		2
	3		3
	4		4
-12 V	5		5
-12 V	6		6
+12 V	7		7
+12 V	8		8
GND	9		9
GND	10		10
GND	11		11
	12		12
	13		13
	14		14
Scope	CR302	Orange	J404/Rear Panel
	U305-5	Yellow	J404/Rear Panel
TTL	U305-5	Brown	J403/Rear Panel
	U305-4	Red	J403/Rear Panel
		Coax Cable	
Aux. Ref.	U301-3		J405/Rear Panel
Aux. Sig.	U301-12	(·)-------	J405/Rear Panel
GND Plane Const Power Bd		Black	Display Board

Ident.	Connector/Location	Type/Color	Connector/Location
	J101/Display Bd	Ribbon	J201/Const Power Bd
	Pin #		Pin #
	1		1
	2		2
-12 V	3		3
-12 V	4		4
+12 V	5		5
+12 V	6		6
AC On	7		7
GND	8		8
GND	9		9
GND	10		10
OUTPUT err	11		11
Low Batt	12		12
Short	13		13
0-500 mA	14		14
Cur sense	15		15
0-200 mA	16		16
Cur Contrl	17		17
Range Sense	18		18
	19		19
Meter GND	20		20
GND Plane		Black	

	J203/Main Bd		200-500 Sw/Front
	Pin #		Pin #
	1	Red	8, 3
	2	Blue	5, 6
	3	Red	1, 2
	4	White/Blue	7
	5	White/Black	4

	J202/Main Bd		Batteries
	Pin #		
	1	White/Blue	B401 (-)/B402 (+)
	2	Red	B401 (+)
	3		
	4	White	B402 (-)
	5		

Ident.	Connector/Location	Type/Color	Connector/Location
	J204/Main Bd		T401/Transformer
	Pin #		Pin #
	1	White/Black	7
	2	Black	8, 11
	3	White/Black	12
	J205/Main Bd		R229/Front Panel
	Pin #		
LIMIT	1	Blue	R229 Arm
	3	Blue	R229 CW
	J401/Rear Panel		
	Pin #		
Interlock	1	Brown	R214/Main Bd
Interlock	2	Red	S201/Main Bd
	3		Earth Ground
	4	White/Black	CR210 Anod/Main Bd
	5	White/Black	CR210 Anod/Main Bd
Reference	6		U301-3/Const Pwr Bd
Signal	7	(-)-------	U301-12/Cnst Pwr Bd
	8	White/Blue	CR204 Cath/Main Bd
	9	White/Blue	CR204 Cath/Main Bd
	T401/Transformer		
	Pin #		
	1	White	S401/Front Panel
	2	Black	T401-6
	5	White	T401-1
	6	Black	S401/Front Panel
	7	White/Black	J204-1
	8	Black	J204-2
	11	Black	T401-8
	12	White/Black	J204-3

Chapter 5

SCHEMATIC DIAGRAMS

5.1 Front Panel Board Layout

5.2 Side Panel Board Layout

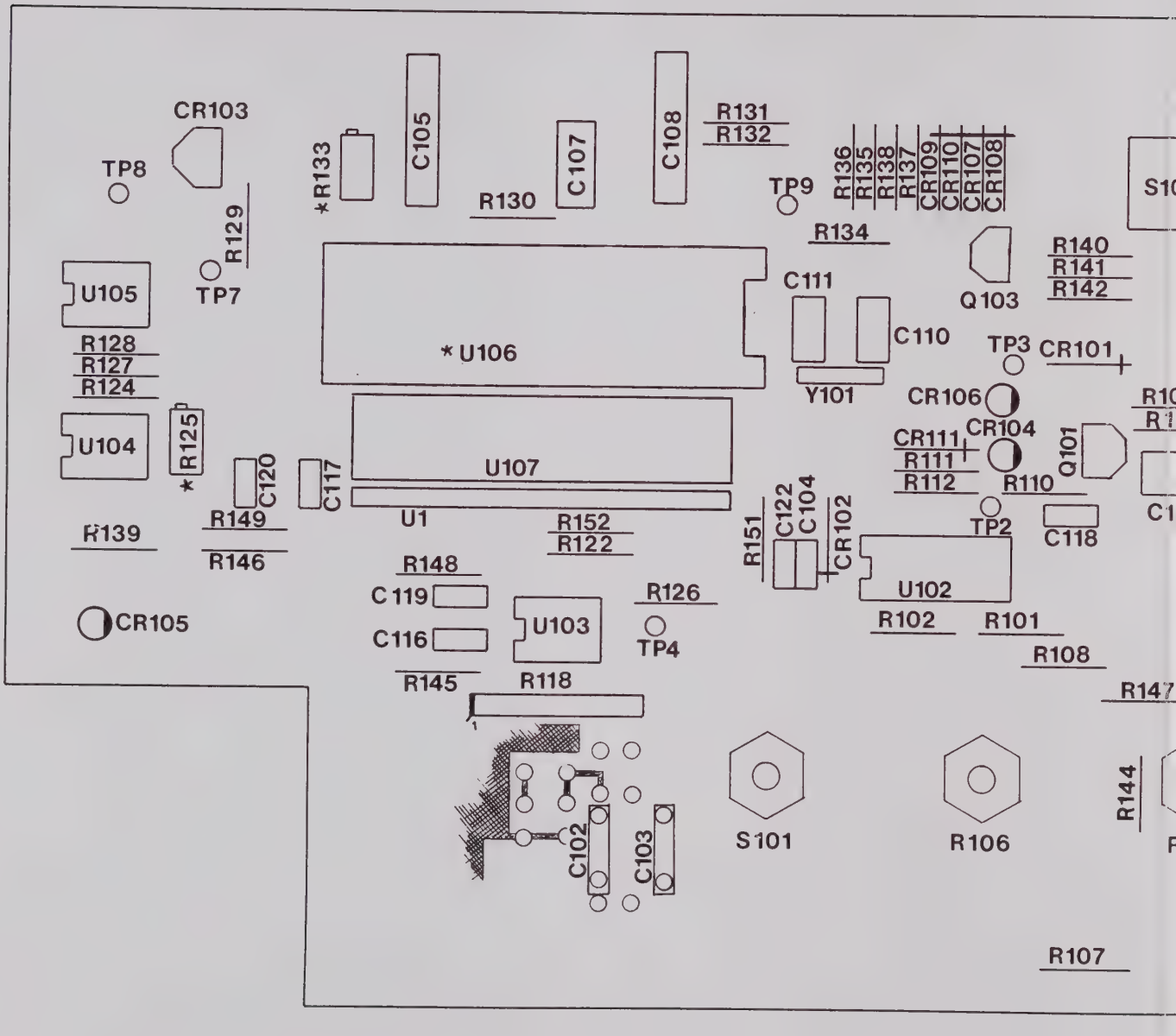
5.3 Rear Panel Board Layout

5.4 Display Circuits

5.5 Current Adjust/Ramp Circuits

5.6 Power Supply/Output Circuits

5.7 Photodiode Feedback Circuits


CR103
TP8
*R133
C105
C107
C108
R131
R132
R130
TP9
R136
R135
R138
R137
CR109
CR110
CR107
CR108
S10
R129
TP7
R134
R140
R141
R142
U105
C111
Q103
R128
R127
R124
*U106
C110
TP3
CR101
Y101
CR106
R10
CR104
U104
*R125
U107
CR111
R111
R112
Q101
R110
C120
C117
U1
R149
R146
R152
R122
R151
C122
C104
CR102
TP2
C118
R139
R148
C119
C116
U103
R126
TP4
U102
R102
R101
CR105
R145
R118
R108
R147
S101
R106
R144
C102
C103
R107

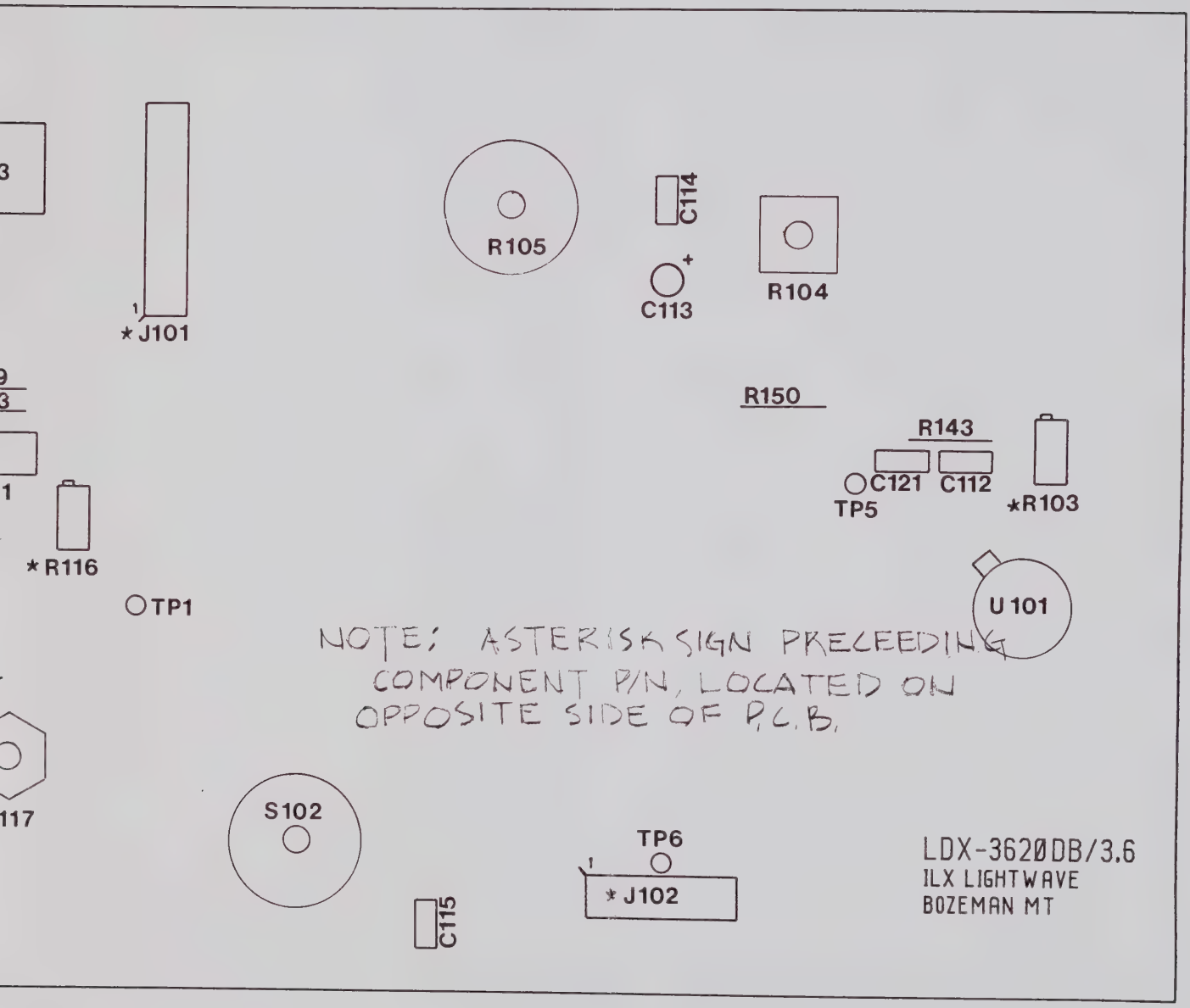
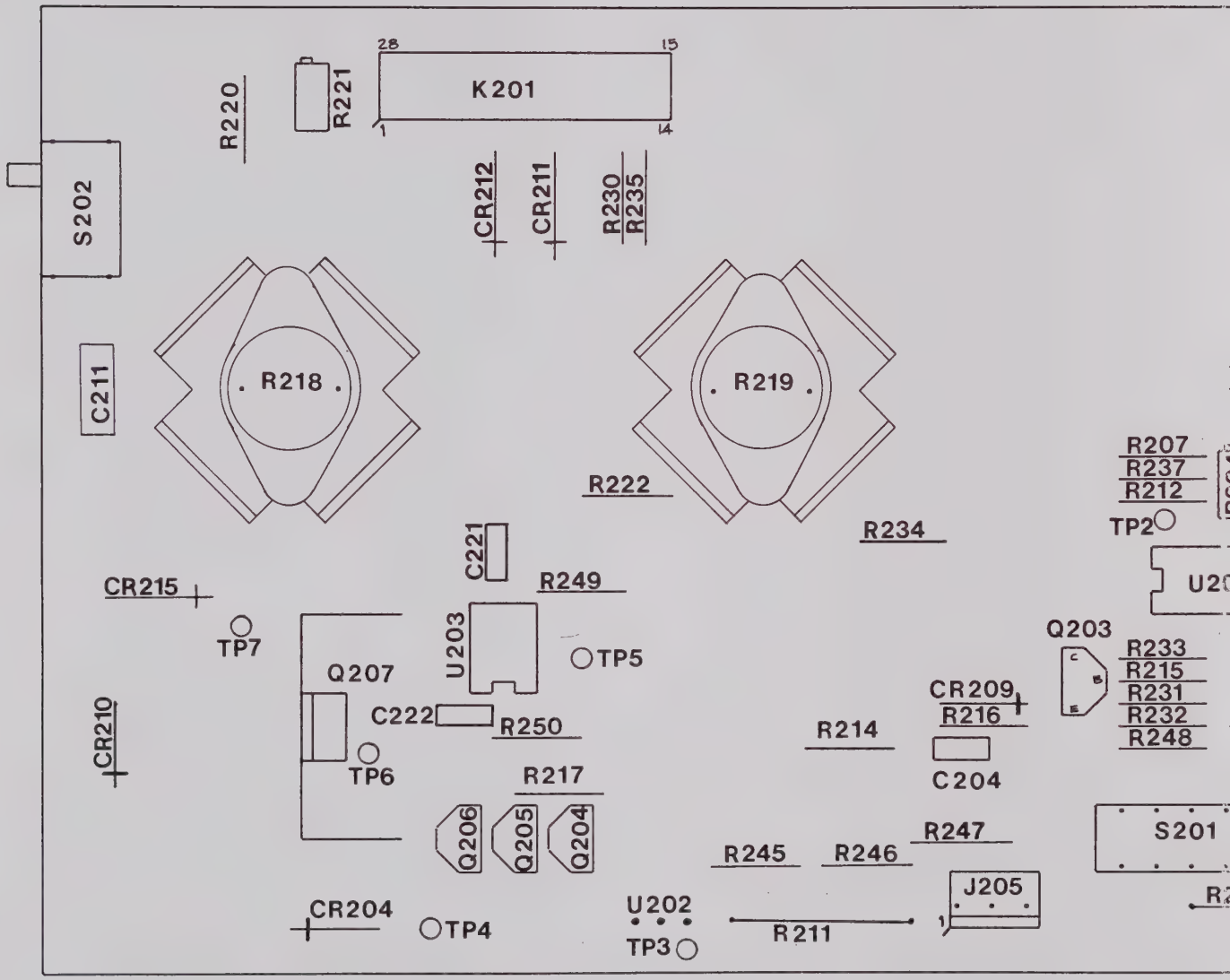


Diagram 5.1 Front Panel Board Layout


28
15
1
14
K201
R220
R221
S202
CR212
CR211
R230
R235
C211
R218
R219
R222
R234
R207
R237
R212
TP2
C221
R249
CR215
TP7
U203
TP5
Q203
R233
R215
R231
R232
R248
Q207
CR209
R216
CR210
C222
R250
TP6
R214
C204
R217
Q206
Q205
Q204
R247
S201
R245
R246
J205
CR204
TP4
U202
TP3
R211

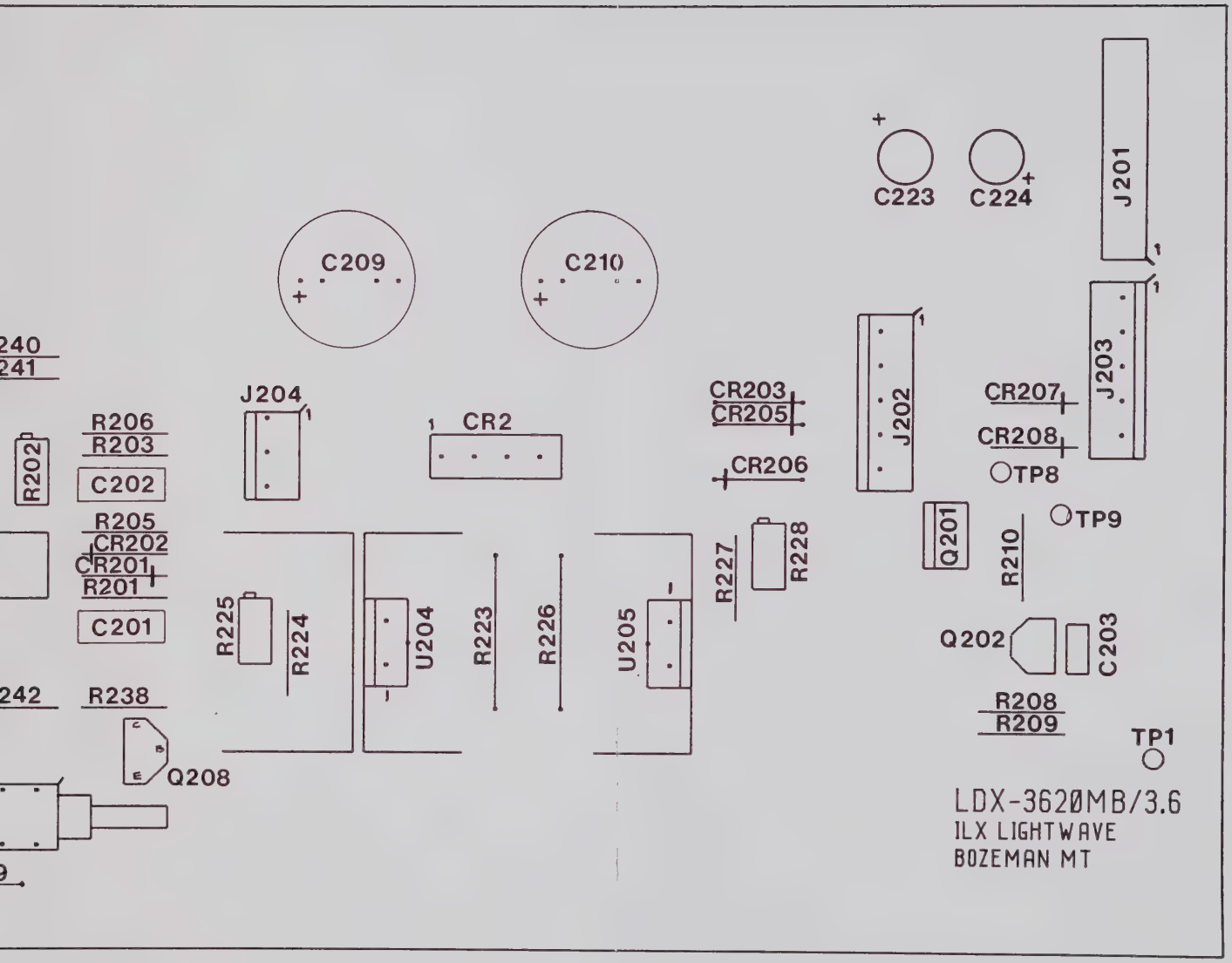
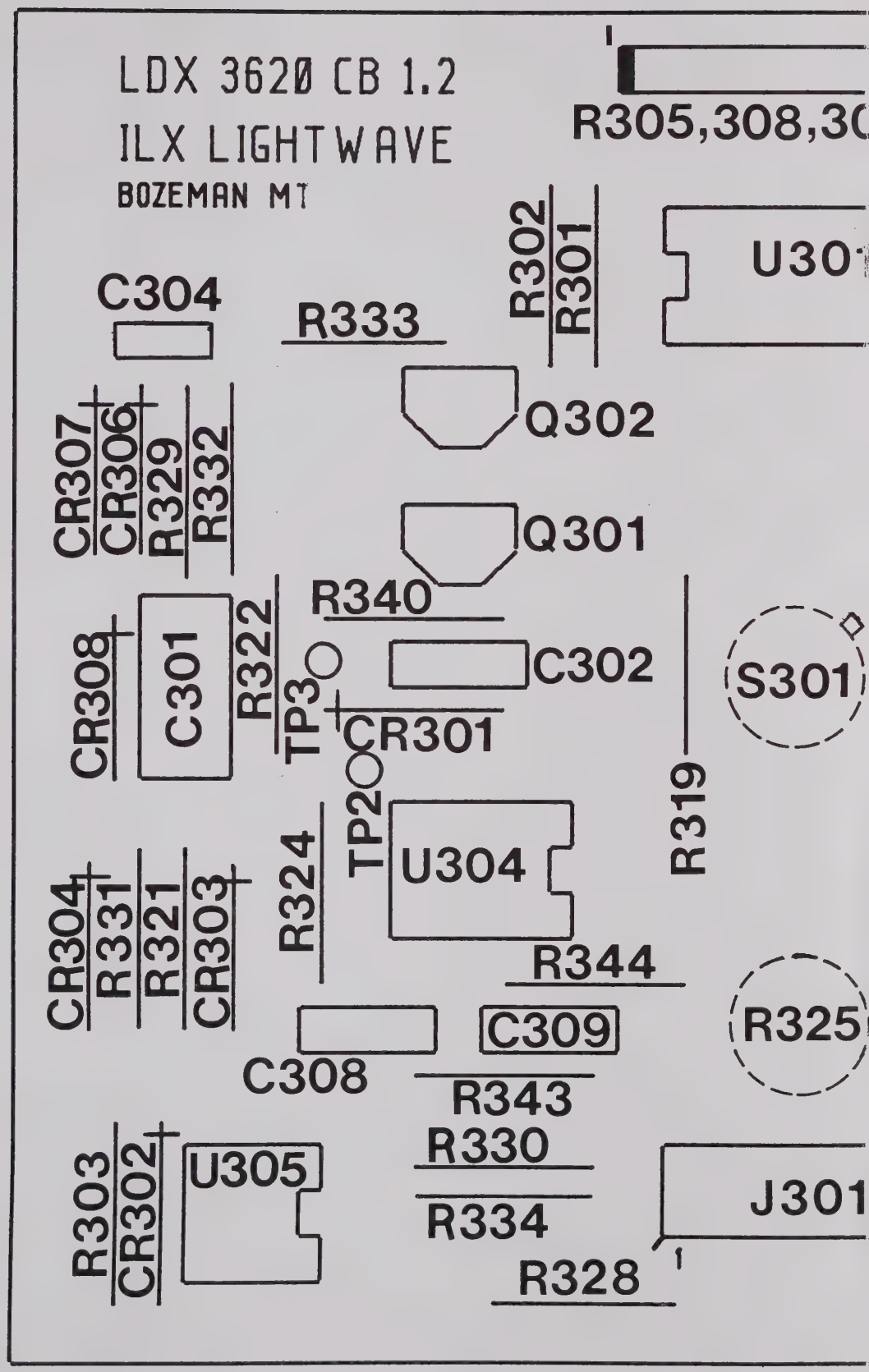


Diagram 5.2 Side Panel Board Layout


LDX 3620 CB 1.2
ILX LIGHTWAVE
BOZEMAN MT
R305,308,30
U30
R302
R301
C304
R333
Q302
CR307
CR306
R329
R332
Q301
R340
CR308
C301
R322
TP3
C302
S301
CR301
TP2
R319
U304
R324
CR304
R331
R321
CR303
R344
R325
C309
C308
R343
R330
R303
CR302
U305
J301
R334
R328

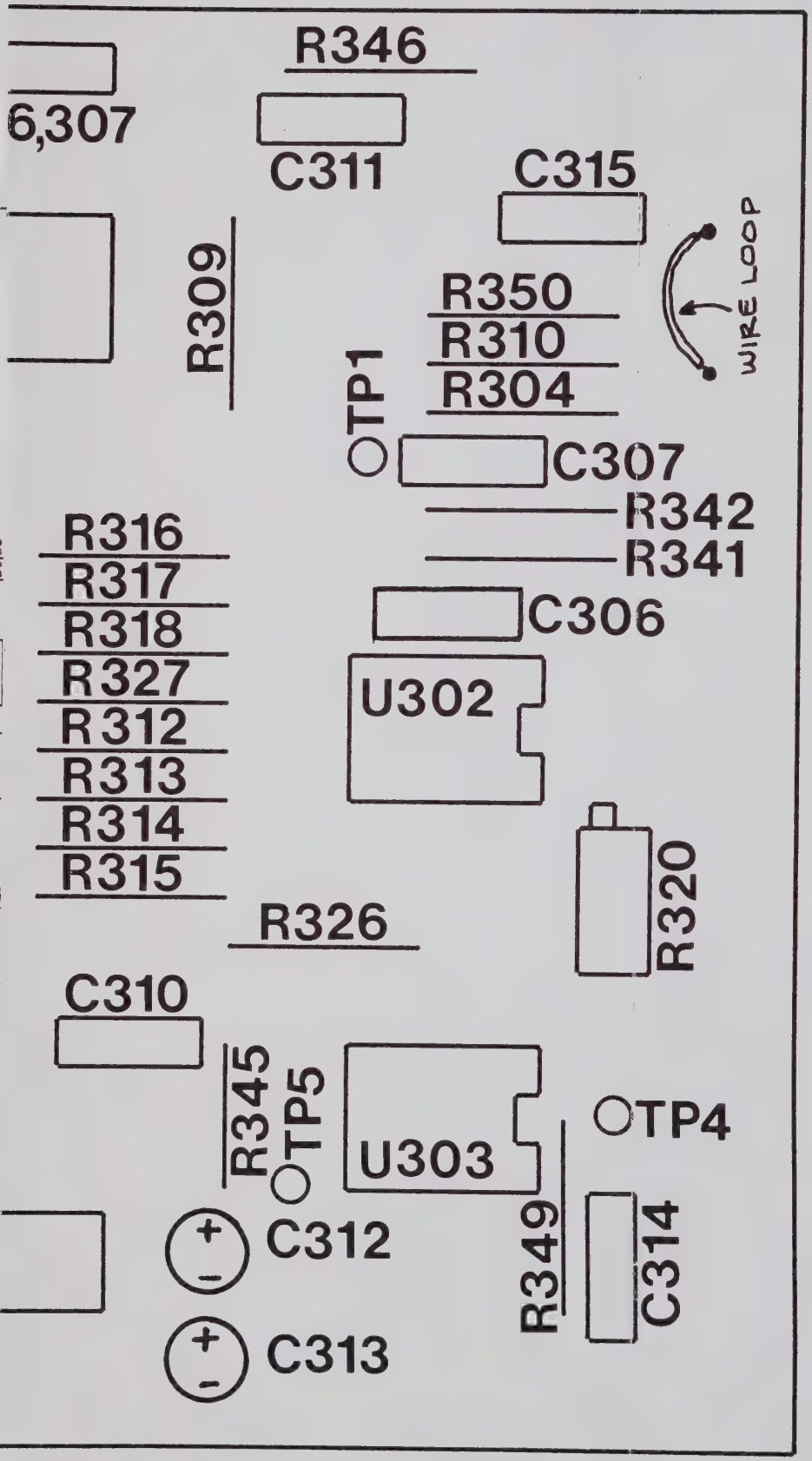
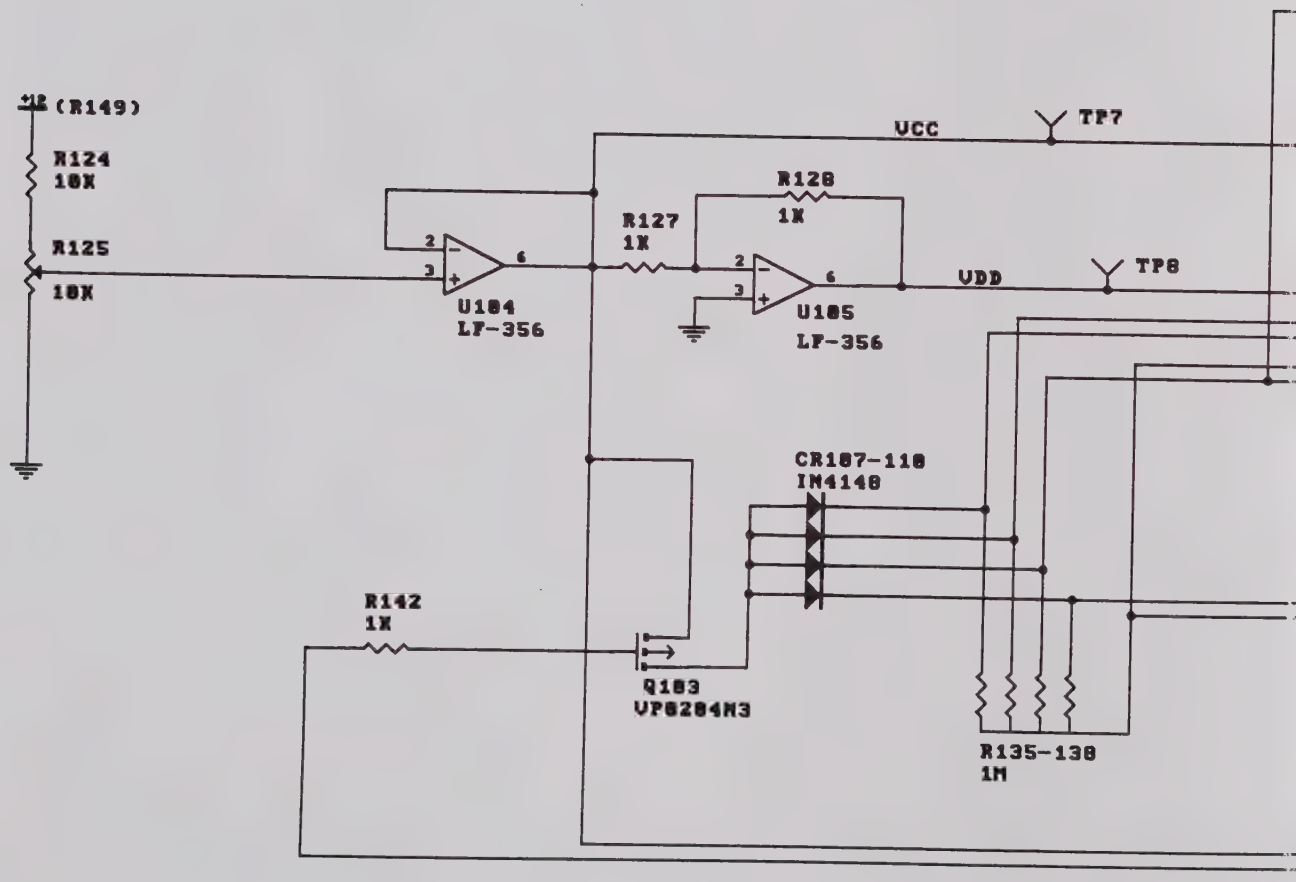


Diagram 5.3 Rear Panel Board Layout


(R149)
R124
10K
R125
10K
U104
LF-356
R127
1K
R128
1K
U105
LF-356
VCC
TP7
VDD
TP8
CR107-110
IN4148
R142
1K
Q103
VP0204N3
R135-138
1M

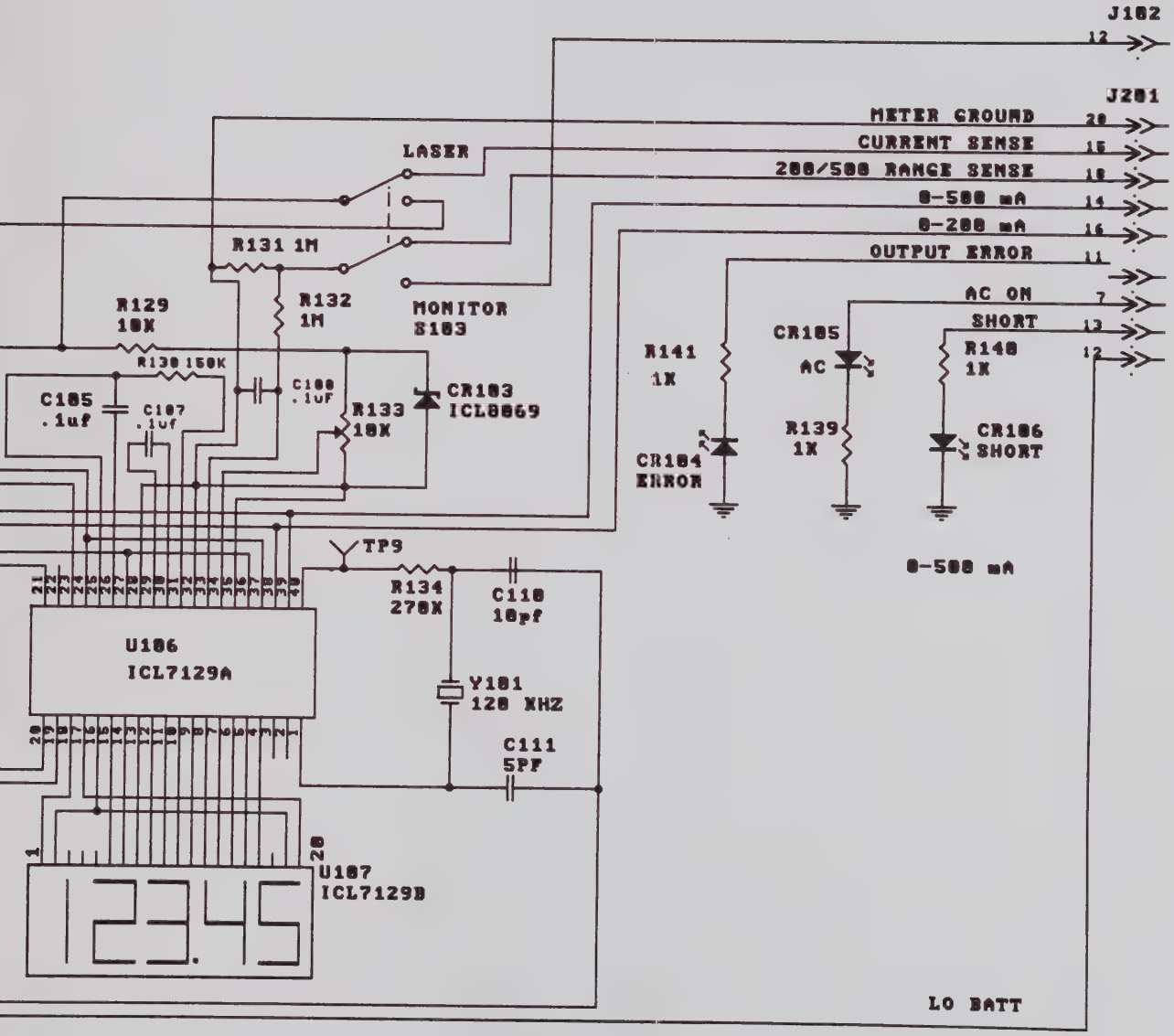
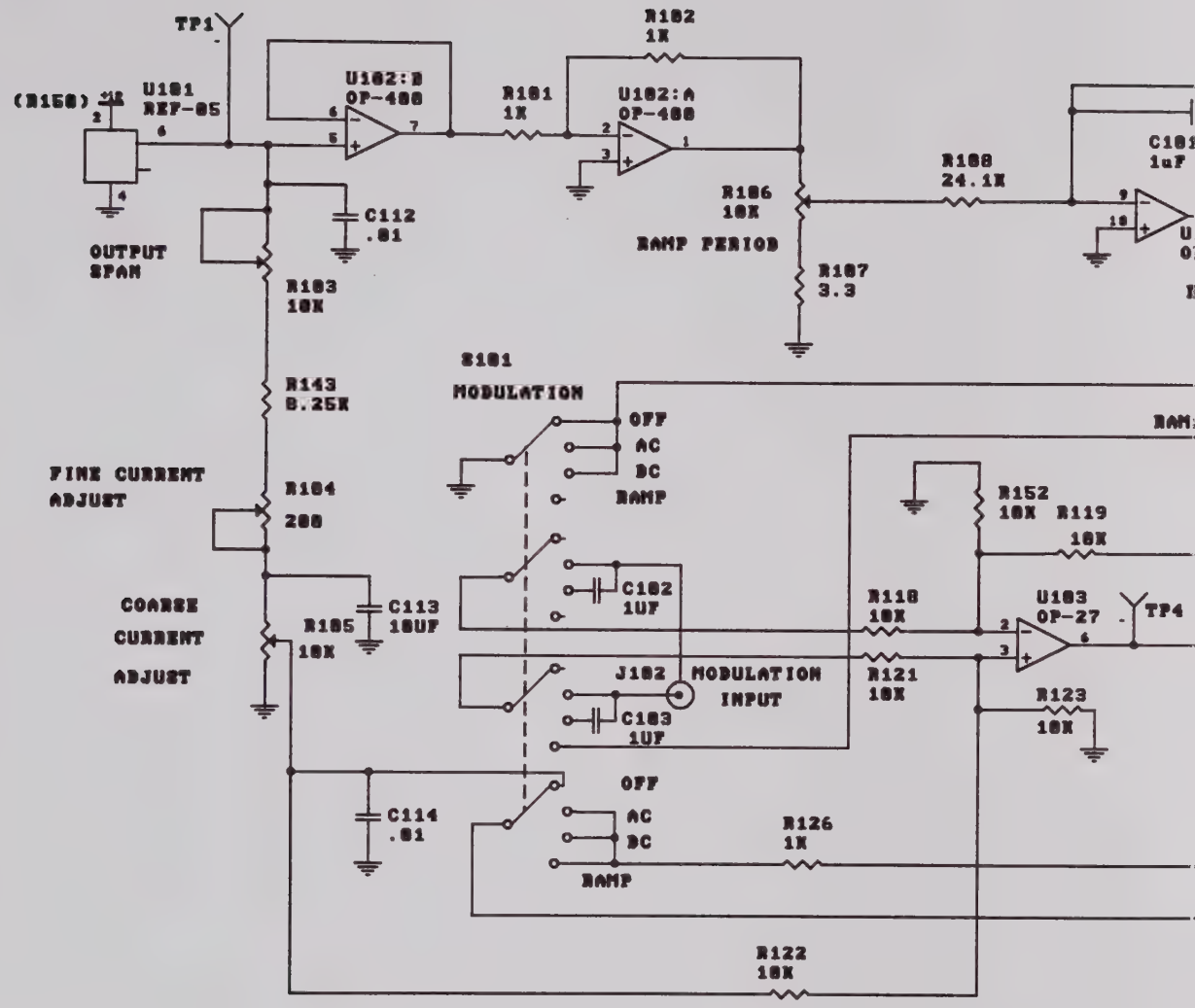
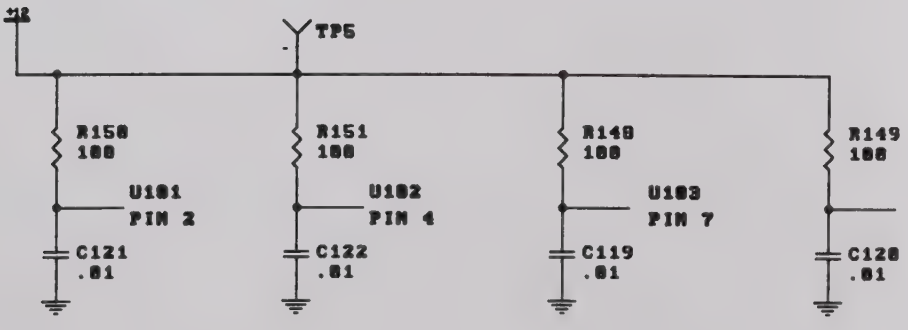
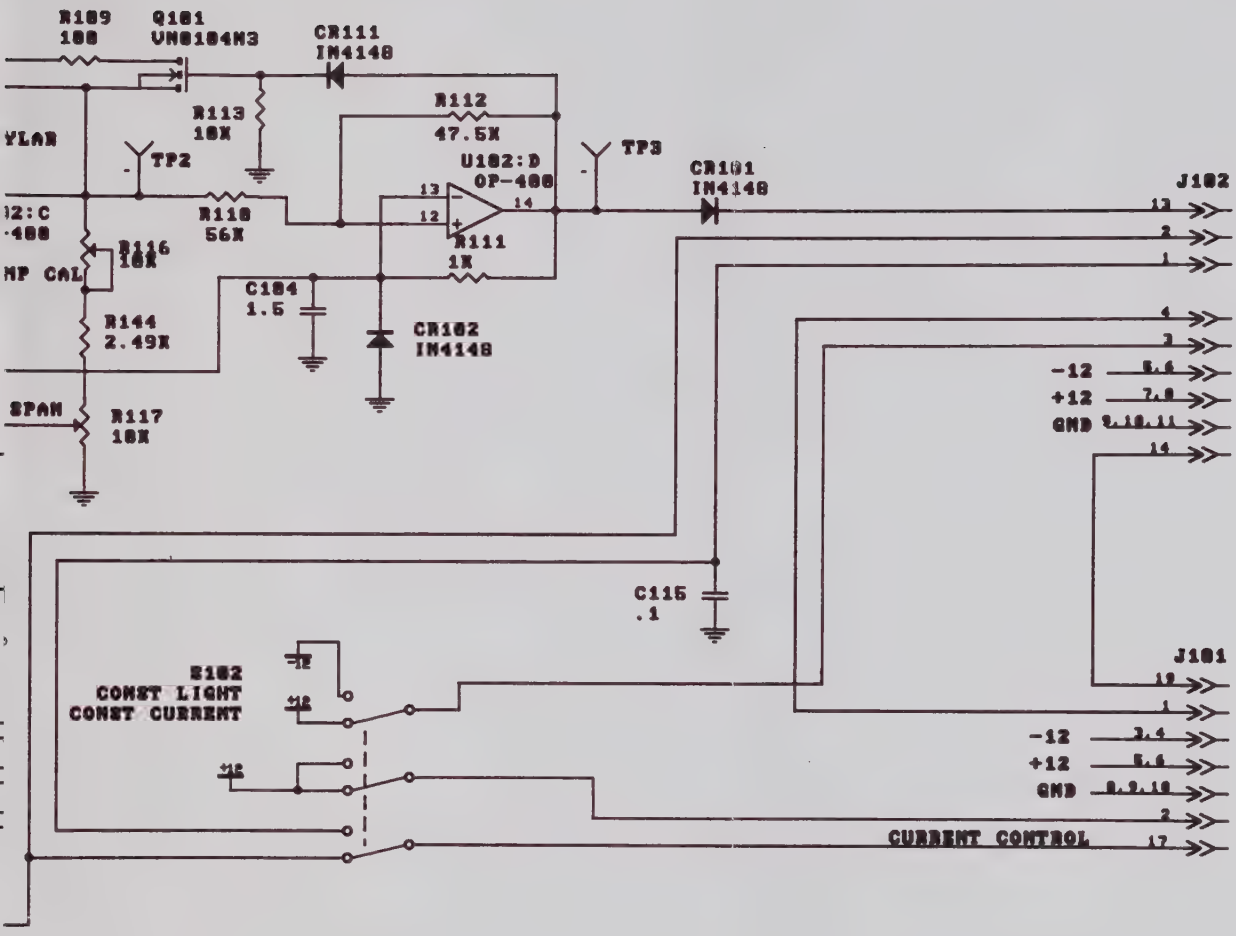


Diagram 5.4 Display Circuits


TP1
(R158)
U101
REF-05
U102:B
OP-488
R101
1K
U102:A
OP-488
R102
1K
R188
24.1K
C101
1uF
R106
10K
RAMP PERIOD
R107
3.3
C112
.01
OUTPUT
SPAN
R103
10K
R143
8.25K
S101
MODULATION
OFF
AC
DC
RAMP
FINE CURRENT
ADJUST
R104
200
R152
10K
R119
10K
C102
1UF
R118
10K
U103
OP-27
TP4
COARSE
CURRENT
ADJUST
R105
10K
C113
10UF
J102
MODULATION
INPUT
R121
10K
C103
1UF
R123
10K
C114
.01
OFF
AC
DC
RAMP
R126
1K
R122
10K


TP5
R150
100
U101
PIN 2
C121
.01
R151
100
U102
PIN 4
C122
.01
R148
100
U103
PIN 7
C119
.01
R149
100
C120
.01



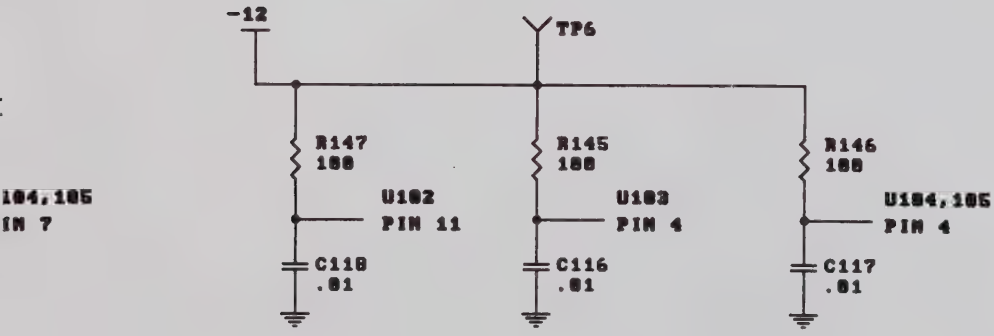
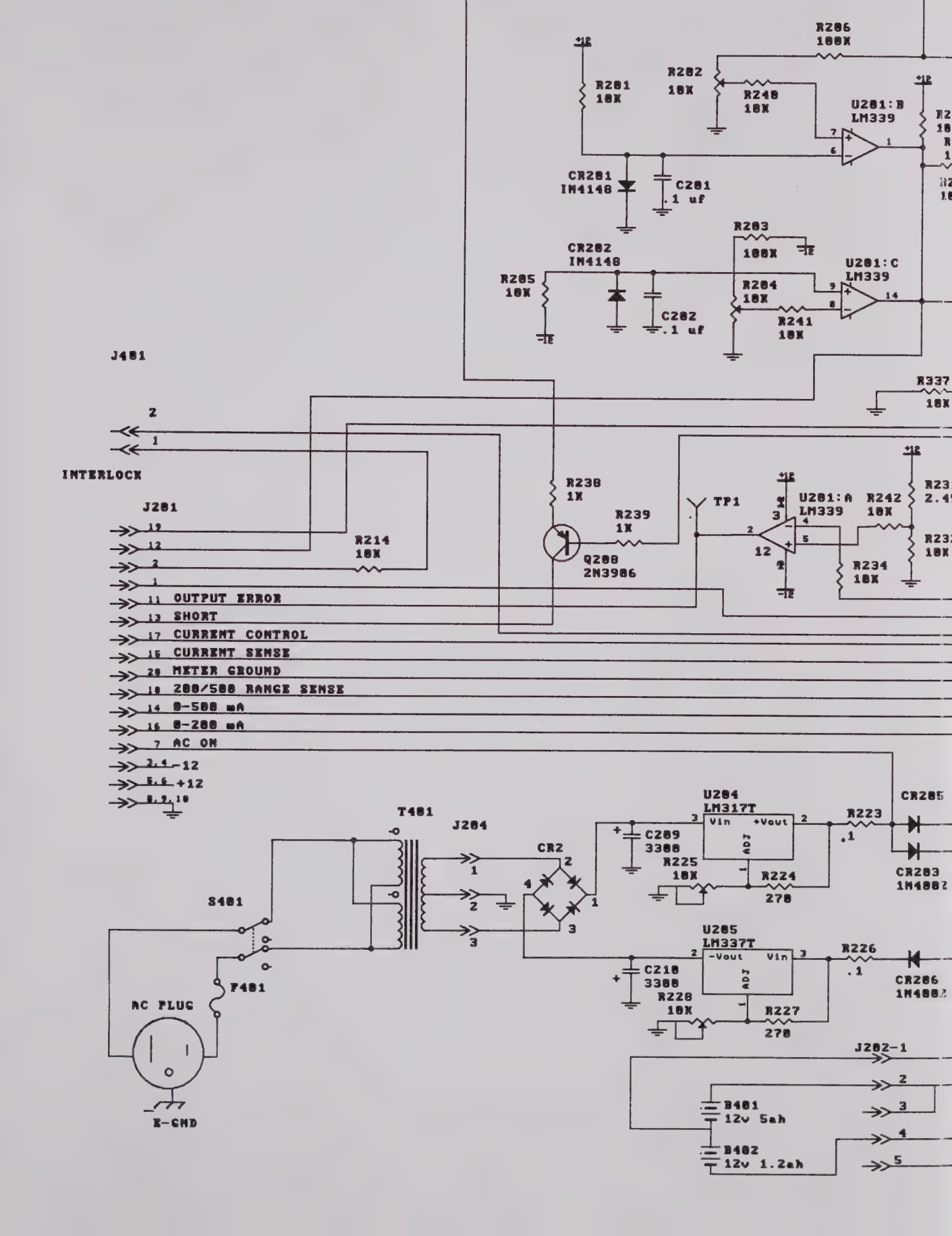


Diagram 5.5 Current Adjust/Ramp Circuits


R206
100K
+12
R201
10K
R202
10K
R248
10K
U201:B
LM339
CR201
IN4148
C201
.1 uf
R203
100K
CR202
IN4148
R205
10K
C202
.1 uf
U201:C
LM339
R204
10K
R241
10K
J401
R337
10K
2
1
INTERLOCK
J201
19
12
2
1
11 OUTPUT ERROR
13 SHORT
17 CURRENT CONTROL
15 CURRENT SENSE
20 METER GROUND
18 200/500 RANGE SENSE
14 0-500 mA
16 0-200 mA
7 AC ON
3,4 -12
5,6 +12
8,9,10
R214
10K
R238
1K
R239
1K
Q200
2N3906
TP1
U201:A
LM339
R242
10K
R234
10K
T401
J204
S401
F401
AC PLUG
E-GND
CR2
C209
3300
R225
10K
R224
270
U204
LM317T
Vin
+Vout
R223
.1
CR205
CR203
1N4002
C210
3300
R228
10K
R227
270
U205
LM337T
-Vout
Vin
R226
.1
CR206
1N4002
J202-1
B401
12v 5ah
B402
12v 1.2ah

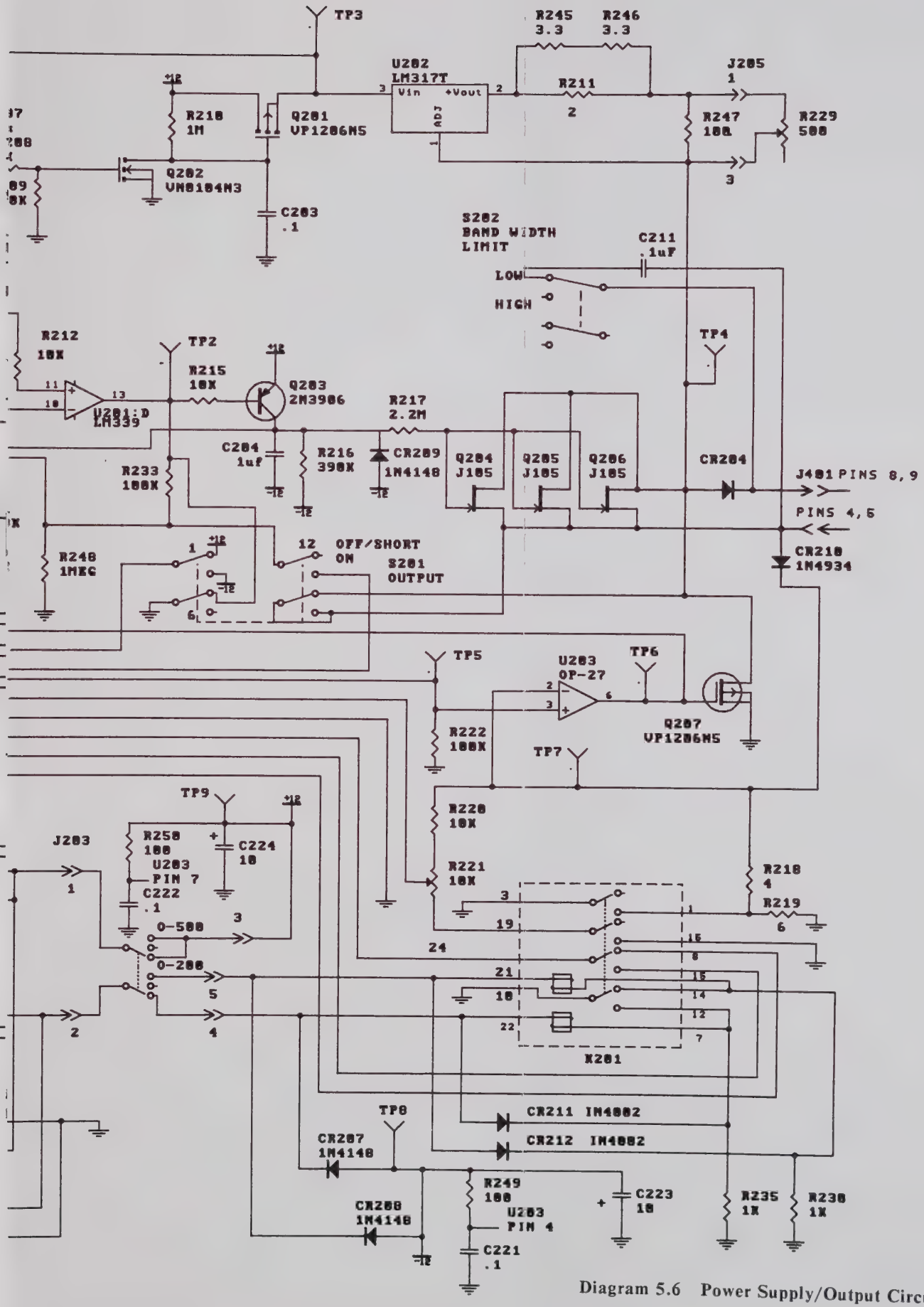
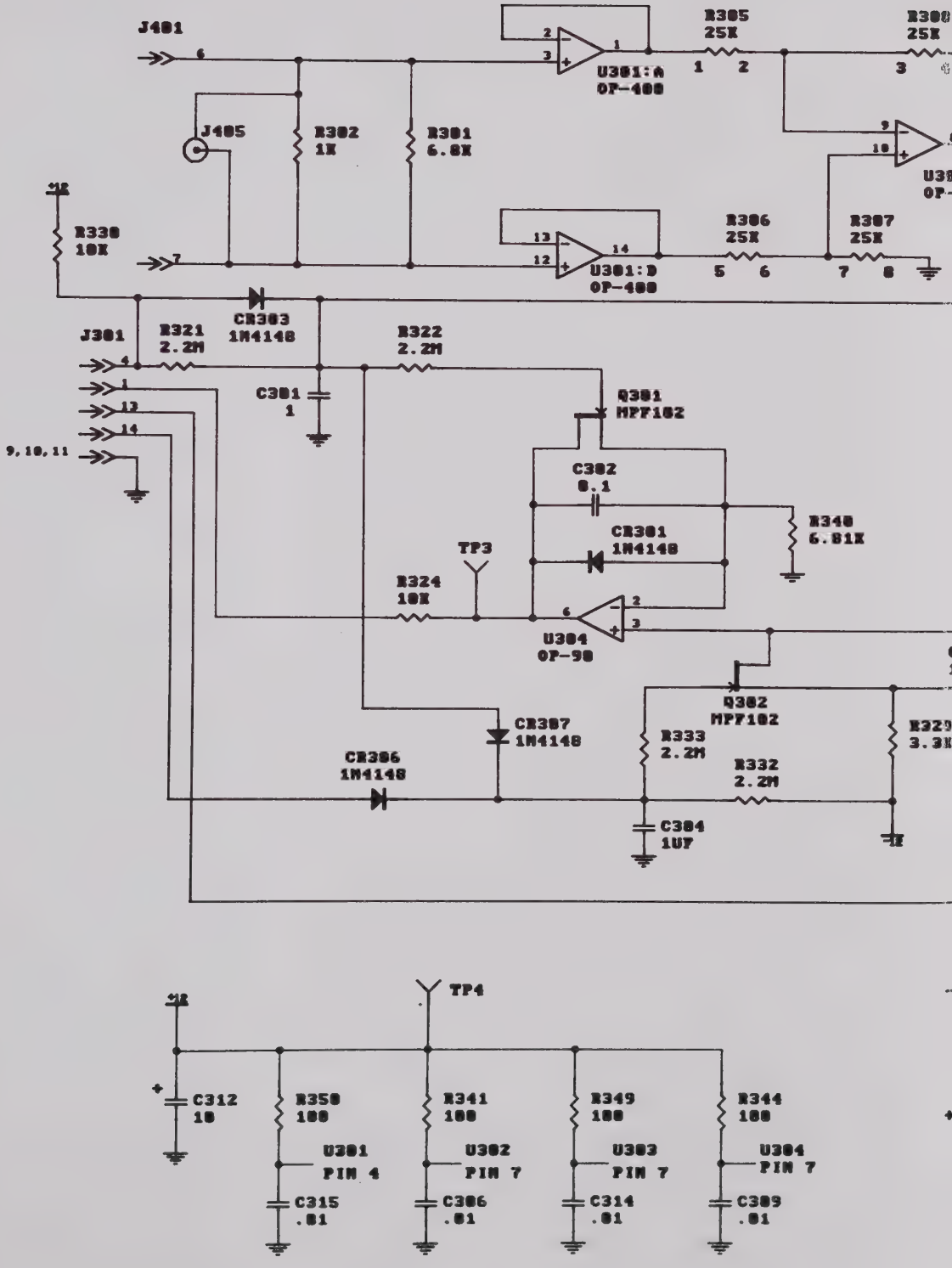
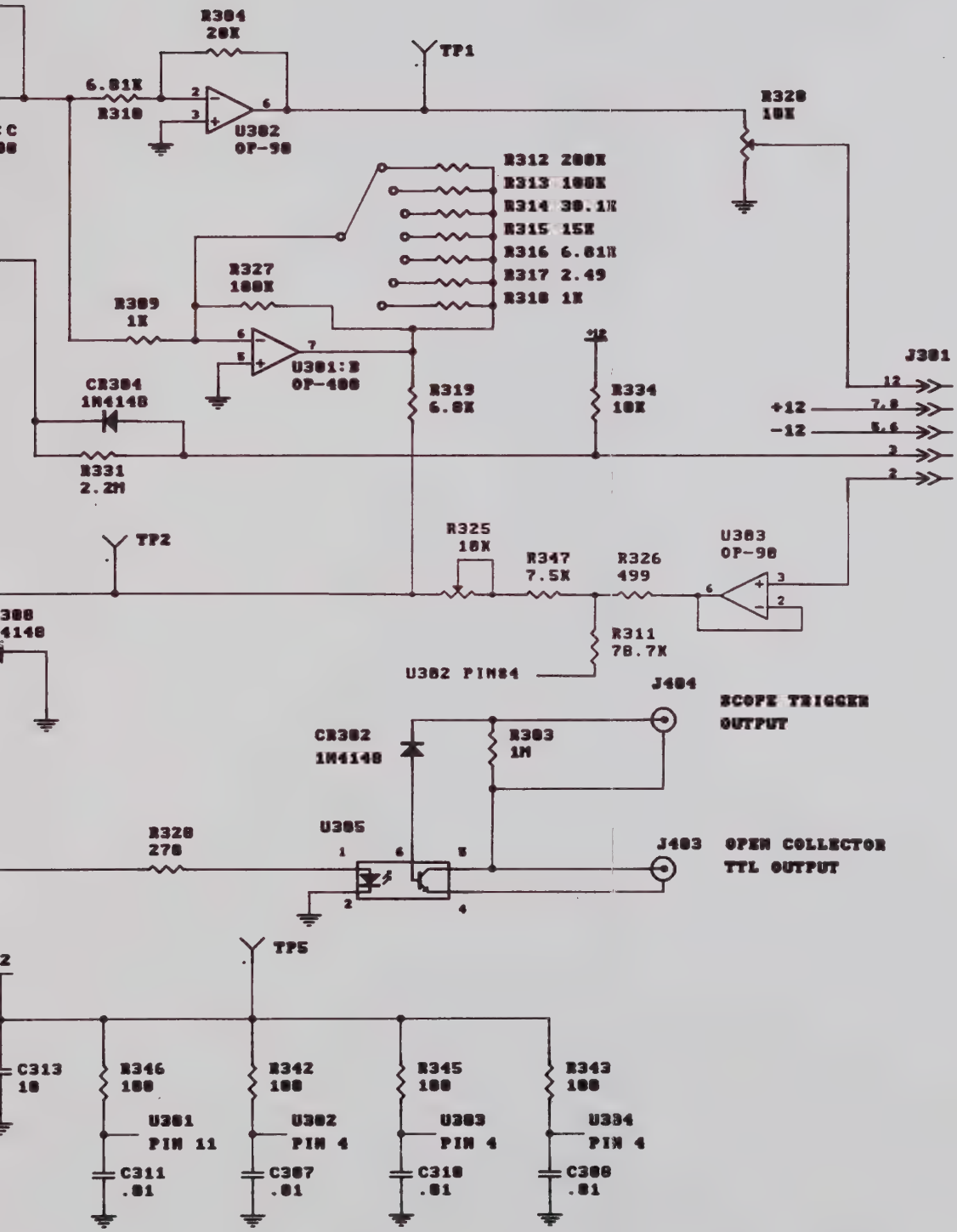


Diagram 5.6 Power Supply/Output Circuits


J401
6
U301:A
OP-400
R305
25K
1
2
R308
25K
3
J405
R302
1K
R301
6.8K
U301:B
OP-400
R306
25K
5
6
R307
25K
7
8
R330
10K
7
CR303
1N4148
J301
R321
2.2M
R322
2.2M
C301
1
4
1
13
14
9,10,11
Q301
MPF102
C302
0.1
CR301
1N4148
R340
6.81K
TP3
R324
10K
U304
OP-90
6
2
3
Q302
MPF102
CR307
1N4148
R333
2.2M
R332
2.2M
CR306
1N4148
C304
1UF
TP4
C312
10
R350
100
R341
100
R349
100
R344
100
U301
PIN 4
U302
PIN 7
U303
PIN 7
U304
PIN 7
C315
.01
C306
.01
C314
.01
C309
.01



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